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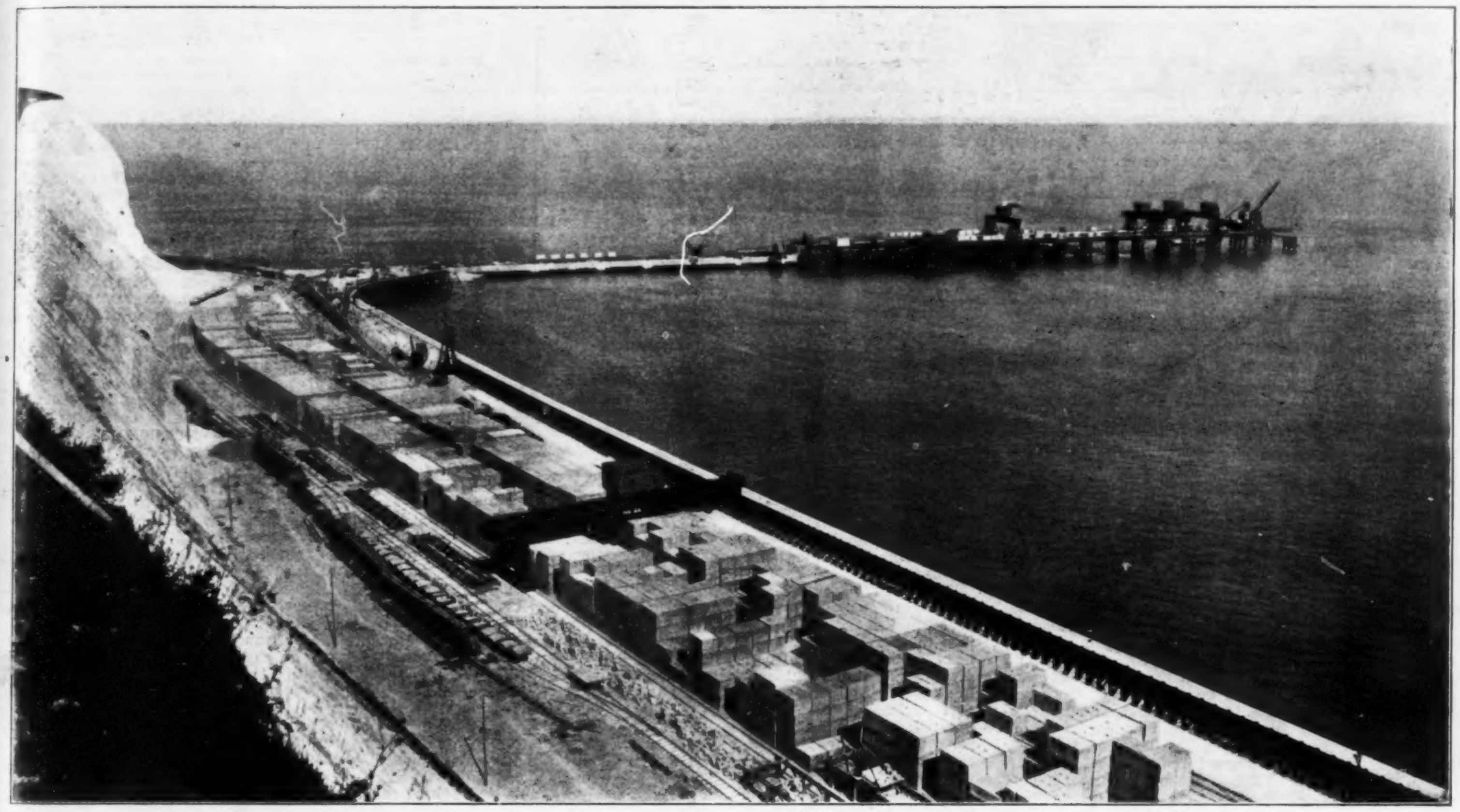
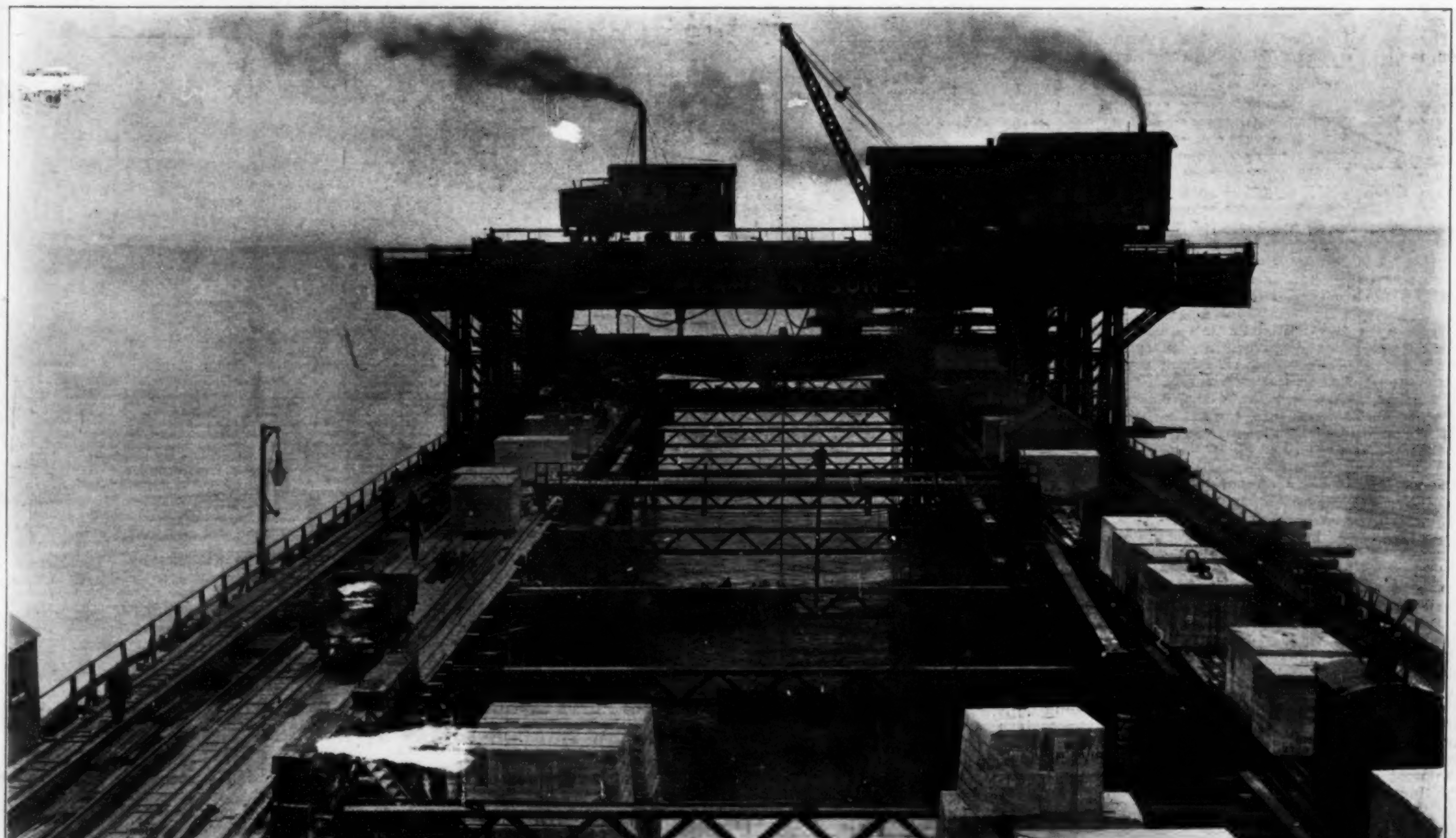


PART OF THE EAST ARM BLOCKYARD AND VIEW OF THE EAST ARM. THE BLOCKYARD STANDS ON TWENTY-ONE ACRES OF RECLAIMED LAND.



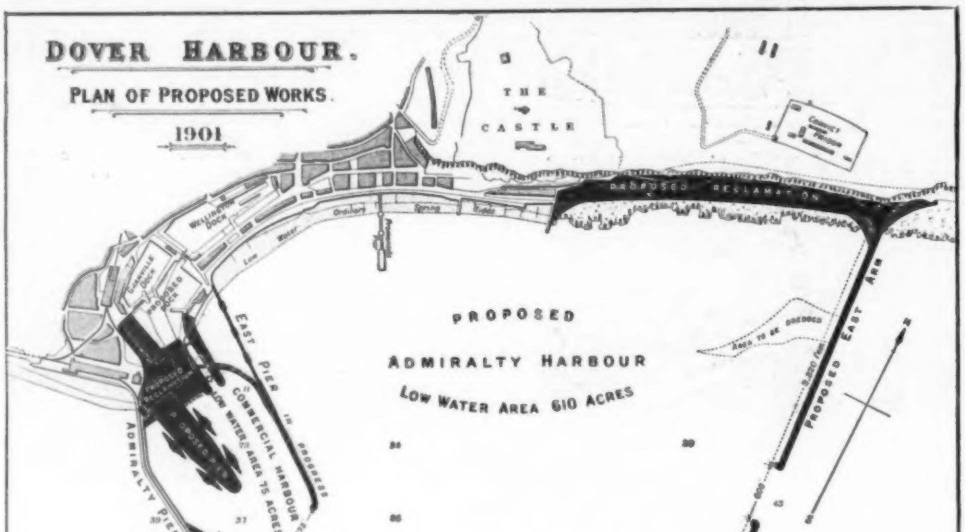
TEMPORARY WOODEN STAGING, RUN OUT ON EACH SIDE OF THE SEA WALL, FROM WHICH ALL OPERATIONS ARE CONDUCTED.

THE NEW HARBOR WORKS AT DOVER.

THE NEW HARBOR WORKS AT DOVER.*

By HAROLD J. SHEPSTONE.

THE new national harbor, which the British Admiralty are building at Dover, on the English south coast, is progressing rapidly, and has now reached a stage when a description of the great undertaking cannot fail to be of more than passing interest. In addition to the work of the British government, the Dover Harbor Board has also obtained Parliamentary sanction and prepared plans for the erection of a new commercial harbor, the building of a pier, the reclaiming of a large piece of ground, etc. It will be seen, therefore, that very extensive operations are now in progress at Dover.



PLAN OF DOVER HARBOR, SHOWING IN HEAVY BLACK LINES AND SHADING THE NEW PIERS AND BREAKWATERS.

Before describing either undertaking, it is interesting to note that the necessity for the erection of the national harbor has arisen through the introduction of the torpedo-boat and destroyer in modern warfare, which makes the Downs, in the English Channel, no longer a safe anchorage for a fleet in time of war. The British Admiralty have been aware of that fact for many years past, and in 1897 the English Parliament sanctioned the construction of a harbor of refuge at Dover for ships of war. In like manner, the body responsible for the commercial facilities of the harbor, fully alive to the importance of Dover as a port of call for the many lines of steamers running between London, Hamburg, Bremen, Rotterdam, and New York, have very rightly decided to improve existing accommodations, with a view to catching additional Continental traffic and inducing the Atlantic liners to call there.

The national harbor, which first demands our attention, is being made by extending the present Admiralty pier 2,000 feet, forming the westward arm of the harbor, and building out from the base of the cliffs, immediately below the old convict prison, a wall, 3,320 feet in length, which will form the east arm of the harbor. A breakwater, 4,200 feet long, will form the southern wall, and will be erected some three-quarters of a mile from the shore and almost parallel with it. These three walls will inclose a water area at low tide of 685 acres. This will afford ample accommodations for a fleet of twenty-five first-class battleships with all the attendant smaller craft, such as gunboats, torpedo-boats, etc. When completed it will be the largest artificial harbor ever built.

The plans for this gigantic undertaking were drawn up by Messrs. Coode, Son & Matthews, consulting engineers to the British Admiralty, while the work of carrying out the project was placed in the hands of Messrs. S. Pearson & Son. Work was actively commenced at Dover in the summer of 1898. At the time of writing, the extension to the Admiralty pier and also the east arm wall of the harbor are nearing completion. Work will be commenced on the breakwater during the summer.

A reference to our plan will give an idea of the extent of the work. One of the first things the contractors accomplished at Dover was the reclaiming of twenty-one acres of ground at the base of the cliffs, extending from the Castle jetty to the root of the east arm of the harbor. To do this a sea wall thirty feet high had to be built, the space between this and the shore being filled in with chalk rubble obtained on the spot by blasting away the tall cliffs. Some 600,000 cubic yards of excavation was required to fill the huge gap. The land having been reclaimed, it was at once turned into a blockyard, where the giant concrete blocks of which the harbor walls are being built are made.

The blocks of which the harbor proper is being built are made in this yard for the erection of the eastern arm. The blocks for the Admiralty extension are fashioned in another blockyard on the seashore to the west of that pier. The eastern blockyard, by far the largest, is the one that calls for a description. Up and down the yard run six sets of elevated rails. Upon these travel six electric mixers. They receive the cement and ballast, mix it as they go, and after the requisite revolutions have been recorded, namely sixteen, drop it into the large wooden molds beneath. In the case of the molds at the farther end of the yard, the desired revolutions have been performed during the period of traveling, so no time whatever is lost. The concrete blocks of course are composed of cement, shingle, and sand, mixed in certain quantities with water. The ballast is brought to the scene of operations by rail to the top of the cliffs, and then lowered by the cliff railroad on to the elevated platform.

When a mold is filled, it is left to set for eight days, when the sides are removed. In three weeks it is ready for use, and is as hard as stone. All blocks above the low water mark are faced with granite masonry. The larger blocks are 14 feet long, about 6 feet high, and weigh 42 tons. The smallest weigh 24 tons.

The construction of the harbor wall is carried on from temporary staging of a very massive kind. At every fifty feet, two sets of six piles are driven firmly into the ocean bed opposite one another, across which heavy iron girders are placed, and in this way the staging is carried out seaward. The majority of the huge piles are 100 feet long and 20 inches square. At first Oregon pine was used, but it has now been supplanted by Tasmanian bluegum. There are two reasons why this wood is preferred. In the first place, it was necessary to weight the Oregon wood, so that in case of accident it would sink and not be a menace to shipping. On the other hand, the Tasmanian bluegum is so dense that it will sink like a stone. It is also immune from the attacks of sea insects. Some idea of its density may be gaged when we say that a pile 100 feet long and 20 inches square turns the scale at nearly 10 tons. It is so heavy that it has to be towed into position between empty barrels. This timber was specially selected and imported by Messrs. Pearson & Son.

Upon this staging large overhead Goliath cranes have been erected, each having a movable steam winch or grab. Some of the cranes weigh 350 tons each. The larger ones have a lifting power of 60 tons on a 100-foot span. Any loose material lying on the sea bed is removed by large mechanical diggers or "grabs," operated from the Goliaths and capable of holding three tons each. The grabs are opened when lowered, and on being raised the teeth are drawn together and into the sea bed, thus excavating the material, which is then brought to the surface, deposited in barges, and taken out to sea for discharge in deep water. The final leveling of the foundation is carried out by means of the diving bells. Altogether, the diving staff number eighty men; that is, dress and bell divers. The former, of course, work in ordinary divers' costumes from boats, and the latter in the big diving bells, of which there are seven. The writer took a trip down in one of these. The men were working in fifty feet of water at high tide. The foundation is being carried down to the solid chalk flint of which the bed of the Channel is composed off Dover. The task of securing the foundation has not been found very difficult, as the strong ocean currents which prevail in the neighborhood keep the bed of the Channel swept fairly clean of debris and mud. Four men work in a bell and stay under water for a period of three hours. The bells are about 17 feet long, 10 feet wide, and weigh about 35 tons apiece; they are lighted by electric light.

The foundation having been secured, the huge blocks are lowered into position by the powerful cranes. The dress divers superintend the laying of these blocks. To prevent the possibility of any slight lateral movement under the shock of heavy storm-waves, the blocks are "joggled." Cylindrical cavities are left between the blocks, and these are filled in with concrete in bags.

As will be seen by our plan, the national harbor will boast of two entrances. The western entrance, at the end of the Admiralty pier extension, will have a width of 800 feet. At low water there will be a depth here of 42 feet, and 60 feet at spring tides. The eastern entrance will have a width of 600 feet, while the depth will be the same as that at the other entrance. Of the 685 acres of water thus inclosed, no less than 315 acres are situated beyond the five-fathom line. The cost of the work is put down at $20,000,000.

In addition to the above scheme, the Dover Harbor Board have decided to spend $5,625,000 in improving the present commercial harbor. A new pier is to be built. It will be 1,100 feet long and 320 feet wide. It will be constructed so as to hold four platforms, two 50 feet and two 30 feet wide. It will also contain eleven lines of railway, and will be provided with four landings for steamboats, which will disembark their passengers under cover at the same time, without causing any inconvenience to one another. The existing outer harbor is to be deepened and converted into a deep-water floating dock, approached through lock gates, which will enable vessels to enter it at any state of the tide. There are two or three other items, mainly of local interest.

The national harbor, of course, is purely a government enterprise, whereas the proposed improvements by the Dover Harbor Board is a private undertaking. To enable this body to carry out the work, they have obtained sanction from Parliament to levy a poll-tax of fifty-five cents on every passenger embarking at Dover. Not only do the Board anticipate a great extension of their already very large Continental traffic, which now averages from 1,000 to 1,500 passengers daily, but they also hope to induce the liners to make it their port of call. Dover is so near the regular track of the many lines of steamers running between London, Hamburg, Bremen, Rotterdam, and New York that it will only require a very slight detour from their ordinary course to pick up at Dover passengers from England, France, Germany, and Belgium, and thus save the time and expense of putting in at Southampton for English passengers and then crossing over to Cherbourg for passengers from the Continent, Dover being as convenient a point for the rendezvous of passengers from all directions as it is for the liners to make it a port of call. In conclusion, it may be added that the scheme has met with the warm approval of the German Emperor and his ministers as well as those of France, Belgium, and Holland. The Hamburg-American Line have already made

MOLDS IN WEST BLOCKYARD. THE MOLDS IN THIS YARD ARE NOT MADE BY THE ELECTRIC MIXERS.

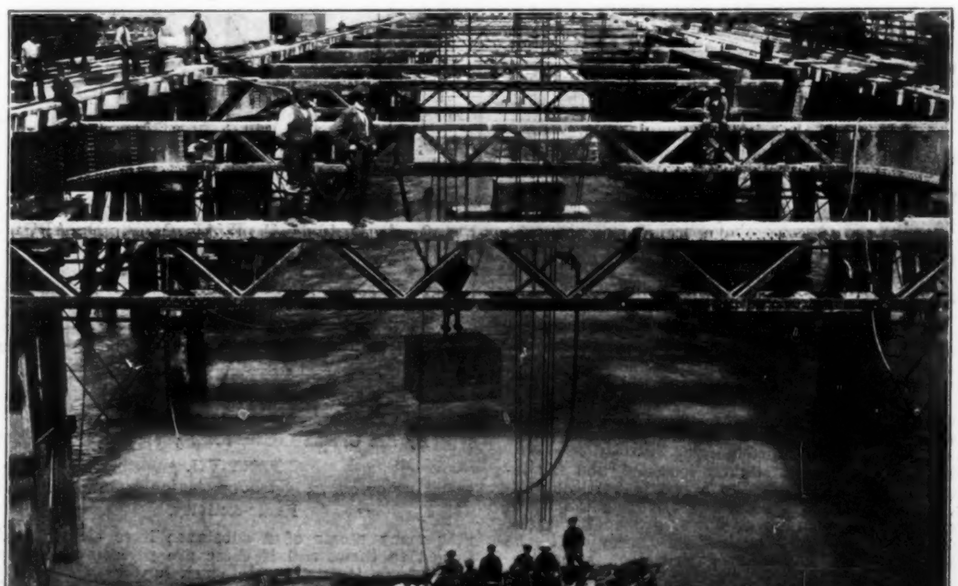
THE NEW HARBOR WORKS AT DOVER.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

arrangements to call at Dover, and will do so on May 1 next. The proposed berths for the Atlantic liners will not then, of course, be finally completed, and in the meantime passengers will be landed by tender.

HIGH SEA AT DOVER DURING THE CONSTRUCTION OF THE SEA WALL ALONG THE EAST ARM BLOCKYARD.

Several of the English steamship companies are negotiating with the Dover Board for landing their passengers at Dover, and the Atlantic Transport Company have expressed their desire to make Dover their stopping place as soon as the necessary work has been carried out.



LOWERING A BLOCK INTO THE SEA.

THE NEW HARBOR WORKS AT DOVER.

Correspondence.

PROF. ALEXANDER GRAHAM BELL ON KITE CONSTRUCTION.

To the Editor of SCIENTIFIC AMERICAN SUPPLEMENT:

In the issues of the SUPPLEMENT, vol. lv., page 22947, of June 13, 1903, and the National Geographical Magazine (vol. xiv., No. 6, June, 1903) are interesting articles by Prof. Alexander Graham Bell on "The Tetrahedral Principle of Kite Construction." Prof. Bell takes as his point of departure the cellular kite shown in Fig. 1, which he says is now universally known as "the Hargrave box kite." Now it happens that the kite represented by Prof. Bell is exactly the one covered by a patent granted to me by the United States Patent Office after a year of full consideration and a vigorous contest with other inventors, which brought letters to the Patent Office from most of the leading kite experts in this country and one from Mr. Hargrave himself. Recognizing Mr. Hargrave as an inventor of the principle of the cellular kite, I did not attempt to attach my name to the improved kite; and this kite, as Prof. Bell says, has become universally known as *the* Hargrave kite; while kites embodying the principle covered by my patent, but differing in detail, are coming to be known by the names of their designers. Yet, oddly enough, Mr. Hargrave himself disowns my style of cellular kite. He said in a paper before the Aeronautical Society of Great Britain on May 26, 1899: "The American copies of my cellular kite have no diagonal struts, the corners being pushed out by horizontal and vertical pieces of wood. In addition they require to be guyed in every direction by steel wires. This style appears to me barbaric." (The Aeronautical Journal, vol. iii., page 50.)

Mr. Hargrave made many forms of cellular kite, but in all there is a central spine of one or more sticks with braces extending or radiating outward. In other words, the skeleton is on the inside of the kite. My improvement consists in removing the skeleton to the outside of the kite, and particularly in removing the longitudinal braces to the corners of the kite.

Notwithstanding Mr. Hargrave's condemnation, I think this results in great advantage, for several reasons: (1) The kite skeleton serves to hold the cloth covering of the kite taut and prevent the vibration and wave motion which occur without the stiffened edges. (2) The posts placed at the corners of the kite give the maximum of resistance to torsion, and hence great rigidity when guyed. (3) The absence of any projecting corners, particularly between the cells, is a great advantage in tandem flying, because secondary kites with projecting corners are very liable to catch on the flying line of the primary kite and dive to the ground. (4) Placing the longitudinal braces in the corners of the kite permits of very simple forms of construction, and hence the general use of the kite for recreation.

The importance of this change is proven by the fact that this style of construction has come into almost universal use. The kites used for scientific work at Blue Hill, by Teisserenc de Bort in France, by the German and Russian governments, and by the United States Weather Bureau, as well as the kites sent out on the various Arctic expeditions, were all of this type.

But the main object of this letter is to point out certain additional reasons to that given by Prof. Bell as to why a large kite cannot be built up of many small ones without increasing the weight per unit area. Prof. Bell quotes a statement of Prof. Newcomb concerning the difficulty of building a large flying structure, because of the law that weight increases as the cube of the dimensions, while surface increases only as the square of the dimensions, so that a structure of double size should weigh eight times as much as the smaller one, but have only four times the lifting surface. This conclusion Prof. Bell thinks is true for models exactly alike, only differing in the scale of their dimensions, but is not true if the large structure is built up of small units. In such a case the weight per unit area of the large structure need be no greater than the individual units. He finds but one difficulty, and that is, as the structure grows large the parts require to be farther apart to maintain stability, and there exists a necessity for empty framework in the central spaces.

A statement by Prof. Le Conte in the Popular Science Monthly several years ago, similar to that made by Prof. Newcomb, led me to a line of experiments similar to that of Prof. Bell in the effort to build up a large structure out of a number of small units. But I found two other difficulties besides that mentioned by Prof. Bell which led me to abandon the effort, and it seems to me that these would apply also to Prof. Bell's structures.

I secured eight small kites such as are used for toys and business advertising and are called the Blue Hill naval kites. A structure built of these flew very well and was very steady, but I found there were serious difficulties in keeping the large structure of the same specific weight as the unit. The chief difficulties were the two following: (1) Each kite was not an independent flying unit, but pulled or pressed against its fellow, and tended to concentrate strain on points which had to be strengthened, and that meant increased weight. For example, if the flying line was attached to one or two points, the total pull of all the units was concentrated on the points of attachment, and these parts had to be strengthened. In such a case the upper units are pulling against the lower and tending to crush them. This effect may be partly obviated by tying a flying line to each unit, and bringing these leading lines to a single line at a distance from the kite; but in that case there is a crushing strain on the central parts, due to the inward pressure of the outer units, so that the central parts must be made heavier. (2) When a structure of many units touches the ground, the unit which first touches the earth has above it the weight of all of the superposed units, and in consequence is crushed, while if it had come to the ground with only its own weight, it would not have sustained the slightest injury. This was so serious a drawback that I gave up trying to build a large kite out of small units without increasing the specific weight.

I did find, however, that one can build up a large flying surface out of small units without materially increasing the relative weight, by tying a number of small surfaces in tandem very close behind each other but without any rigid connection. Such a scheme has drawbacks, but is useful for certain purposes.

Prof. Bell does not mention these difficulties in building up a large structure of small units. Perhaps he has overcome them by his principle of tetrahedral construction. It would have been a help to other experimenters if Prof. Bell had given the weights per unit area of his kites. He speaks of lifting one of his kites by means of a galloping horse. This means a speed of 10 to 15 miles an hour. The kites used at Blue Hill, containing 75 square feet of lifting surface in two rectangular cells, have repeatedly floated in a wind of 10 to 11 miles an hour, recorded at the kite, and sustained a Fergusson meteorograph weighing three pounds besides two or three pounds of wire. In June, 1897, I saw a kite built by C. H. Lamson, consisting of two cells with 600 square feet of lifting surface. This kite flew beautifully in a breeze of 15 to 20 miles an hour, and later aided by several men running with it against the breeze, the kite lifted a man inside of it from the ground, where the wind must have been lighter and carried him to a height of about 50 feet, which was considered the limit of safety. This flight was witnessed by Mr. Lamson, Mr. Rotch, Mr. Fergusson, and myself.

In increasing the size of kites of exactly similar models, the weight undoubtedly increases somewhat more rapidly than the surface, but does not approximate the cube of the dimensions. The reason is that only the sticks increase in size, the surfaces exposed to the wind remain of the same thickness through wide limits. I do not know the law of increase of weight to surface, but our experiences at Blue Hill are that if a kite 4 feet high and sufficiently strong for practical work weighs 1.5 ounces per square foot, then a similar one 8 feet high and sufficiently strong for practical work will weigh 2 ounces per square foot. Mr. Lamson's kite, which was 30 feet high and contained 600 square feet of surface, weighed I think 4 ounces per square foot.

HENRY HELM CLAYTON.

Blue Hill Observatory, Hyde Park, Mass.

WESTINGHOUSE STEAM TURBINE AND ELECTRICAL POWER MACHINERY FOR PHILADELPHIA SUBWAY.

ONE of the largest contracts for steam turbine and electrical power machinery recorded in America has just been closed by Westinghouse, Church, Kerr & Co., covering 15,000 kilowatts of steam turbine and approximately 50,000 kilowatts of electrical generating and converting machinery, for equipping the new rapid transit subway and elevated system, now under construction in Philadelphia. The most interesting feature of the equipment to be installed is that steam turbines are to be used exclusively for power generation in the new central station now under construction. There will be three turbines installed, each of 5,000 kilowatts normal capacity, which will be of the type now being built by the Westinghouse Machine Company for large powers. The turbines will be direct connected to Westinghouse three-phase, 25-cycle generators, and all units will run at 750 revolutions per minute with 175 pounds of steam, 27½-inch vacuum, and possibly 100 to 150 degrees of superheat. The three units will operate in multiple upon a common bus bar, and power will be distributed at a nominal potential of 13,000 volts directly from the station without the use of any intermediate transformers; for this purpose the generators are wound for high potential.

The new power station will be located upon the Delaware River near the foot of Green street, and is laid out for an ultimate capacity of 50,000 kilowatts, it being the idea of its designers to concentrate at this point the entire generating equipment at present distributed among a number of smaller stations. The

location of the new station upon the river bank secures excellent coaling facilities and an inexhaustible supply of water for condensing purposes.

The present equipment will furnish power for the subway, and some reserve power for the surface traction system pending the execution of proposed plans for centralizing the entire power system.

The contract also comprises a large amount of transforming and converting machinery, to be installed in the several sub-stations which will be built at various locations in the district covered by the transit system. This machinery will be used for converting the high-tension alternating current from the power station into low-potential direct current for use on the third rail of the traction system. The first installation will comprise fourteen 1,000-kilowatt and two 500-kilowatt rotary converters. Each of the 1,000-kilowatt rotaries will be furnished with three 375-kilowatt stepdown transformers and each of the 500-kilowatt rotaries with three 175-kilowatt transformers of similar design. The electrical equipment will be built by the Westinghouse Electric and Manufacturing Company.

The new rapid transit system now under construction will cover the entire business district of Philadelphia, and includes a two and four track subway about 1¼ miles in length, extending from the Delaware River along Market Street to a point near Twenty-third Street, a short distance from the Schuylkill River. At Broad Street an appropriate central terminal station will be erected. The enterprise is one of the most important in American railway development, and the introduction of the steam turbine in such large sizes is particularly gratifying by reason of the confidence shown in this comparatively new type of prime movers.

A NEW CAPILLARY ELECTROMETER.*

By George J. Burch, F.R.S.

Fig. 1 is a perspective diagram of the instrument in its final form, and Fig. 2, *a*, *b*, *c* and *d*, shows the details of the trough which is the essential part. The support *A* is cut from a solid block of ebonite 9 cm. long, 5 cm. wide and 2 cm. thick. It is first cut to shape, holes drilled for the binding screws *E* and *F*, and the piece *B* then separated from it by two saw-cuts.

V-shaped grooves are cut to receive the capillary *C*, which is firmly clamped under *B* by *E* and *F*. The longer limb of the U-tube *D* passes through a hole drilled lengthways through the lower end of *A*, which is slit about half way up with a wide saw-cut, so that it may be pinched together by the screw *G*. Adjustments for setting the capillary at right angles to the optic axis and parallel to the slit of the photographic recording apparatus are provided for by the stout brass plate *K*, bent at right angles, one end of which is fastened by a binding screw at *L* to the back of *A*, and the other by a similar screw, *M*, to the adjustable stand of the projection microscope. The brass plate *K* is so shaped that there is a space of about 3 mm. between it and the left-hand side of the ebonite support *A*, in order to leave room for the adjustment of the latter about *L* as a center.

The construction of the trough is shown in the full-size diagrams, Fig. 2, *a*, *b*, *c*. A piece of mica, such as is used for lamp shades, is cut to the shape *a* with a pair of scissors. Two or three thicknesses may be taken if one is not enough. Four holes are drilled with a needle in the positions shown. A thin piece of the best clear mica is then laid on a pad of blotting paper, the piece *a* placed on it, and four corresponding holes pricked through with the needle, the piece being afterward cut to the shape *b*. Finally, *a* and *b* are fastened together by four little loops of No. 30 platinum wire, and the whole trimmed to shape with the scissors. The trough is then hung by two platinum chains (made of No. 30 wire, with long links, as shown, enlarged at *d* (Fig. 2), so that the acid may not creep up them) from the hooks shown in Fig. 1. These hooks are best made of half-round wire, doubled like a linch-pin, sliding easily but firmly in holes on each side of the capillary, as in Fig. 1.

The operation of putting in a capillary is as follows: The instrument is fixed to any convenient support by the screw *M*. The milled head *G* is loosened, and the U-tube *D* drawn down and turned aside. The whole instrument is then tilted backward to an angle of 45 deg. from the vertical. In this position the trough *H* hangs clear of the capillary. If the capillary has been already filled and connected with the pressure tube, the nuts *E* and *F* must be unscrewed far enough for the tube to pass sideways into the clamps, but a new capillary may be easily and safely inserted from below after merely loosening *E* and *F*. It must then be filled to within 2 cm.—not nearer—of the top, with recently distilled mercury from a perfectly clean pipette, connected with the pressure apparatus,† and some mercury forced through.

The screw *M* is then slightly loosened, and the instrument raised cautiously to a nearly vertical position. The trough *H* is adjusted by sliding the hooks from which it hangs up or down, or bending them, until the capillary rests against the center of it—the apparatus being tilted back during each alteration. When these adjustments have been made, the inside of the trough is wetted by touching it with a glass rod dipped in dilute sulphuric acid of 25 per cent, and the apparatus is tilted forward until the wet trough swings against the capillary and sticks to it. A piece of thin cover-glass—or of mica if very high powers are to be used—slightly wider than the trough, is picked up by a pair of fine forceps, wetted on one side with the acid, and placed carefully against the trough, to which it adheres, holding it firmly against the capillary, the lower edge of the glass resting against the platinum loops with which the trough is fastened together (see Fig. 2, *c*).

The U-tube is then turned back into position, cautiously raised until the lower edge of the glass just dips into the acid, and clamped by the screw *G*. Finally the trough is gently shaken or pushed to and fro in the plane of the mica, until the acid rises in it to the required height and all the bubbles are expelled.

The trough is held together so firmly by surface tension that it seems at first sight a difficult matter to take off the cover-glass without breaking the capillary. It may, however, be done with the greatest ease, as

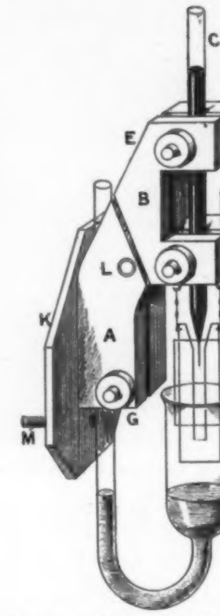


Fig. 1.—HALF FULL SIZE.

follows: The screw *G* is loosened, and the U-tube *D* drawn down and turned aside. A small beaker, filled with water, is held in its place and raised until the trough *H* is completely immersed, when the slightest movement causes the glass to fall off. The apparatus is then tilted back, so that the trough swings clear of the capillary, which may be washed or even wiped, and the trough dried, replaced, and a new cover glass put on in less than three minutes.

The definition, with these electrometers, is perfect. The capillary touches the cover-glass throughout its length, so that any dry objective can be used. The microscope should not, however, be left focused on the capillary, lest the acid should chance to get between the objective and the cover-glass—an accident which I have known to happen in very damp weather.

My only fear in designing this instrument was lest contact with the mica should contaminate the acid and so spoil the tubes. There does not, however, seem to be any such effect. I have had some mica troughs in use for nearly three years, and have never once been troubled with a sticky capillary, and even with induction shocks they will stand more than the old type on account of the larger quantity of acid in the

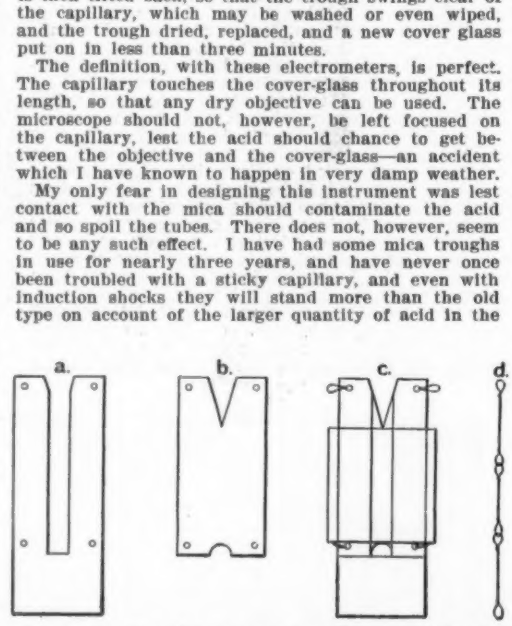


Fig. 2.—A, B AND C, FULL SIZE. D, ABOUT TWICE FULL SIZE.

U-tube. They are easier to make than my old "normal type" on account of the straight capillary, and so far as I can judge they seem likely to supplant both it and my previous projection electrometer.—The Electrician.

* Abstract of a paper read before the Royal Society, November 20, 1902.

† Full details of the pressure apparatus, the cleaning of the tubes, and the method of drawing capillaries were given in my book on the "Capillary Electrometer in Theory and Practice," reprinted from Electrician, 1896.

[Concluded from Supplement No. 1433, page 22968.]

ON ELECTRONS.*

By Sir Oliver Lodge, F.R.S., Vice-President.

PART VII.

SUMMARY OF OTHER CONSEQUENCES OF ELECTRON THEORY.

Radio-Activity.

If many atoms of a substance have electrons attached to them, and if these are performing orbital revolutions, it is natural to ask how then can it be that substances are not constantly emitting waves and radiating away their energy. Fortunately owing to the brilliant researches of Becquerel, Curie, and others, certain substances have been found in which the radiation intensity reaches a very perceptible magnitude; and it appears that this radiation may be of several kinds—

1st, of waves or pulses analogous to Röntgen radiation, probably;

2d, of rays analogous to Lenard or cathode rays consisting of electrons and ions bodily shot off, certainly;

3d, of detached portions of the substance itself not charged with electricity, but emanating like an odor, and possessing like the rest of the substance an intrinsic radiating power, and capable of attaching itself to other materials in the neighborhood so that they too acquire temporary radiating power.

The substances which possess any noteworthy amount of this radiating power are substances with very high atomic weight, and their emitting power would appear to be probably due to an internal commotion and collision between the atoms, of sufficient violence to detach, and as it were evaporate every now and then, some of the smaller particles; and also by the shock of the collisions to generate some feeble Röntgen rays.

It is easy to grant that whenever there are actual collisions of sufficient suddenness some radiation of this kind must be emitted; but we cannot help asking, why does not the quiet orbital revolution of electrons round atoms, in a substance not in a high state of thermal disturbance and not possessing specially massive atoms, why does not this also give rise to a perceptible amount of radiation and loss of energy? One answer that has been given is as follows:

The radiators are not isolated or independent, and surface radiation is maintained by layers at greater depth in the substance. Moreover the radiators are so close together that they are in all sorts of phases within the first quarter wave length, a length which embraces a multitude of them; wherefore a multitude is a worse radiator than one, because they interfere and produce but little external or distant effect; like the two prongs of a fork, or two neighboring organ pipes, or the front and back of a vibrating wire.

But I doubt if much answer is wanted, save one of a very different character, viz., that radiation of a low temperature order is as a matter of fact always going on from all substances; that energy is conserved and constancy of temperature persists merely because loss is equal to gain, because absorption compensates radiation, not because radiation ceases; and that to make an estimate of the amount of radiation so occurring it would be necessary to suppose the body in an inclosure at absolute zero; when undoubtedly its kinetic energy *would* rapidly leak away, and be dissipated. The whole subject of radio-activity is a large one, upon which I do not propose to enter here and now. Suffice it to realize that any difficulty of explanation in connection with it is not the fact itself, but rather why it is not more notorious.

However, so far as the most striking and interesting excessive photographic and electric radio-activity of certain rare substances is concerned, it has been already hinted that the greater part of that does not consist so much in the emission of radiation proper—whether in the form of pulses of X-rays or any other form—as in the flinging off of particles, negatively charged particles or electrons as a rule, but also sometimes, according to Mr. R. J. Strutt, of positive ions also. The faint photographic influence of ordinary substances observed by Dr. W. H. Russell seemed to suggest that incipient power of this kind is not limited to bodies with heavy atoms like uranium, radium, polonium, etc., as described by Becquerel and the Curies, though these substances show it to an extraordinary degree; Dr. Russell, however, appears to have traced his at first interesting effects to the merely chemical action of hydrogen peroxide.

The whole subject, together with the allied one of the loss of charge from hot bodies, first discovered by Dr. Guthrie long ago, is one that demands special attention and treatment, for which there is no opportunity now.

Solar Corona, Comets' Tails, Magnetic Storms, and Auroræ.

Another subject on which it is tempting to enlarge is the explanation of various astronomical and meteorological phenomena by the electron theory.

The theory of auroræ has recently been elaborated by Arrhenius; but the whole doctrine of emanations from the sun, and of repulsion of small particles both by his light and by his probable electrification, is a matter that has been familiar to me for several years, through conversation with Fitzgerald and others.

The earth is in fact a target exposed to cathode rays, or rather to electrons emitted by a hot body, viz., the sun. The gradual accumulation of negative electricity by the earth is a natural consequence of this electron bombardment, and the fact that the torrent of particles constitutes an electric current of fair strength gives an easy explanation of one class of magnetic storms; which have been long known, by the method of concomitant variations, to be connected with sun-spots and auroræ. The electric nuclei would also serve as centers for condensation of atmospheric vapor at high altitudes and so be liable to affect rainfall.

Nevertheless it is true that these theories have been well elaborated of late by Arrhenius; and his explanation of the aurora by means of the catching and guiding of rapidly moving electrons by the earth's magnetic lines of force, so as to deflect them from the tropics and conduct them in long spirals, along the lines, to the poles, there to reproduce the phenomena of the vacuum-tube in the rarefied upper regions of the atmosphere, is particularly definite and pleasing. Some of the other astronomical suggestions he has made are likewise of considerable interest.

VALIDITY OF OLD VIEWS.

Now that the doctrine of electricity (at least of negative electricity) as located in small charges or charged bodies is definitely accepted, and now that a current can be treated as the locomotion of actual electricity, it may seem as if some doubt were thrown upon the doctrine, which a little time ago was spoken of as a "modern view," that the energy of an electric current resides in the space round a conductor. There is no inconsistency, however. The whole of the fields of an electron are outside itself; it is in its fields that its energy resides, and it is in the space round it that energy is conveyed when it moves; for the ether in that space is subject to the co-existence of an electric and a magnetic field. So, also, its inertia resides in space round it, for it is accounted for by the E. M. F. set up when its magnetic field changes, that is when its motion is accelerated.

In dealing with the inertia of matter it is commonly supposed that the inertia resides in the matter itself; whereas electrical inertia is known to reside in the space round the nucleus. Yet we have been emphasizing and opposing the view that material inertia and electrical inertia are essentially one and the same.

Is there no inconsistency here?

The appearance of inconsistency vanishes when we

* Excerpt from a paper read before the Institution of Electrical Engineers and published in the Journal of Proceedings of the Institution.

come to calculate and realize how extremely local and concentrated the intense part of the field of an electron is. There is a sense in which it can be said that a moving body, for instance a vortex ring, disturbs the whole atmosphere; but any perceptible disturbance resides very near the ring. So it is with an electron. The magnetic field falls off inversely as the square of the distance from the moving nucleus, and hence at a distance far less than a millimeter, less even than the size of an atom, it is quite inappreciable. The whole magnetic field on which its inertia depends lies practically very close to the electron itself; it is just its extremely small size that enables this concentration to be possible, and even in a closely packed mercury atom there is practically no encroachment of the field of one electron on its neighbors. They are all independent, each with its own inertia, almost isolated from the others; for if it were not so, the mass of a body in close chemical combination would not continue constant, but would diminish. Whether it does diminish in the least degree is a question perhaps worthy of attack.*

The momentum of a moving charge at ordinary speeds is simply inversely as the radius of the sphere which holds it, as stated above, but the localization of this momentum, which is the point we are now considering, is given generally in Thomson's Recent Researches in Electricity and Magnetism, p. 20, and may be realized approximately as follows:

The momentum depends on the co-existence and product of the electric and magnetic fields. Each field varies inversely as the square of the distance from the moving charge; and their vector product is, as regards direction, perpendicular to the radius vector at any point, and proportional at ordinary speeds to the sine of the angle between the radius vector and the direction of motion, while in magnitude it falls off as the inverse fourth power of the distance. All this can be realized by common sense with very little trouble.

So, then, take a moving electron, and consider the distribution of its momentum in the space round it. Between its surface and a space of a hundred times its diameter, 99 per cent of its momentum is contained.

So, within the boundary of an atom, which is a hundred thousand times an electron's diameter, there is practically none of its momentum not included.

And even in one of the comparatively closely packed atoms, e. g., in a platinum or mercury atom, the overlapping of momentum for each constituent is extremely small, since their average space apart is some thousand times the size of each constituent electron.

Consequently the assertions that an electric current is a transfer of electrons, and that the energy of a current travels in the space surrounding the moving electricity, are statements not inconsistent with each other. Nor are the statements inconsistent that the mass of a body resides in its atoms, and that inertia or momentum is a property due to the self-inductive influence of the electromagnetic field surrounding a moving electric nucleus. So also with the way in which a current is propelled. The pace of progression of electrons through a solid may be considerable (see next section) but it is very far below the pace at which a telegraphic signal travels along a wire. They must be propelled by a lateral action, transmitted through the ether with the speed of light appropriate to the surrounding insulator, by some arrangement which "Modern Views" symbolized in the form of cogwheels; they cannot be impelled by end thrust. The electric current is a more material entity, or has a more nearly material aspect, than was thought probable a little while since; but all that was taught about its mode of propulsion and the diffusion of the propelling force from outside to inside through successive layers, as it were, of the wire, all that was taught about the paths by which the energy travels and arrives at point after point of the wire, there to be dissipated as heat, remains true.

Number of Ions in Conductors.

The immense number of electrons that are necessary to make up the mass of a piece of platinum, or of a lump of matter like the earth, can readily be estimated; so, also, it is easy to imagine that an enormous number must be traveling in order to give customary strengths of current such as can readily pass through a liquid.

Through a gas a limit is soon found to the available number, and accordingly the conductivity of an ionized gas falls off if we call upon it to carry more than a certain current, called the saturation current. See investigations by Townsend and others. But I am not aware of any experimental indication of such a limit in solids or liquids at present. In solids the pace of travel is unknown, though it has been ingeniously surmised, and is thought to be very great; considerations of centrifugal force would make the speed of each electron during an atomic encounter equal to about 10^8 centimeters per second; views based on Maxwell's theorem about equal distribution of energy among the particles of mixed gases suggest 10^7 for the average speed of electrons at ordinary temperatures in a solid where they were free, that is a hundred kilometers or sixty miles per second; though, since each particle is subject to constant changes of direction, this is by no means the pace of straightforward progression. But in liquids they are attached to atoms, and the pace of progression is known both theoretically and experimentally with considerable accuracy, and is comparable to an inch an hour for customary gradients of potential.

The total current is $n\,e\,u$; and to give a unit c. g. s. current at so low a speed we can reckon how many ions there must be.

For $e = 10^{-20}$ electromagnetic units;

so if we take $u = 10^{-3}$ centimeter per second,

then the number of ions engaged in conveying the c. g. s. unit of 10 amperes is $n = 10^{23}$. But, after all, this is nothing very great. It is only about the number of atoms in a cubic centimeter of liquid, and by applying a greater gradient of potential the ions can be made to move faster. By gradually narrowing down the section of a liquid conductor under a given gradient of potential, it might seem possible to get evidence of an approach to a saturation-current-density in liquids. The observed accuracy of Ohm's law* under such conditions, however, is against this experimental possibility.

CONCLUSION.

The subject is very far from exhausted, but I must not attempt to cover more ground. The most exciting part of the whole is the explanation of matter in terms of electricity, the view that electricity is, after all, the fundamental substance, and that what we have been accustomed to regard as an indivisible atom of matter is built up out of it; that all atoms—atoms of all sorts of substances—are built up of the same thing. In fact the theoretical and proximate achievement of what philosophers have always sought after, viz., a *unification of matter.* And another surprising and suggestive result is that the spaces inside an atom are so enormous compared with the size of the electrical nuclei themselves which compose it; so that an atom is a complicated kind of astronomical system, like Saturn's ring, or perhaps more like a nebula, with no sun, but with a large number of equal bodies possessing inertia and subject to mutual electric attractive and repulsive forces of great magnitude, to replace gravitation. The radiation of a nebula may be due to shocks and collisions somewhat like the X-radiation from some atoms.

The disproportion between the size of an atom and the size of an electron is vastly greater than that between the sun and the earth. If an electron is depicted as a speck one-hundredth of an inch in diameter, like one of the full-stops on this page for instance, the space available for the few hundred or thousand of such constituent dots to disport themselves inside an atom is comparable to a hundred feet cube; in other words, the atom on the same scale would be represented by a church 160 feet long, 80 feet broad, and 40 feet high, in which therefore the dots would be almost lost. And yet on the electric theory of matter they are all of the atom that there is; they "occupy" its volume in the sense of keeping other things out, as soldiers occupy a country; they are energetic and forceful though not bulky, and in their mutual relations they constitute what we call the atom of matter; they give it its inertia, they enable it to cling on to others which come within short range, and by excess or defect of one or more constituents they exhibit chemical properties and attach themselves with vigor to others in like or rather opposite case.

That such an atom, composed only of sparse dots, can move through the ether without resistance is not surprising. They have links of attachment with each other, but so long as the speed is steady they have no links of attachment with the ether; if they disturb it at all in steady motion it is probably only by the simplest irrotational class of disturbance which permits of no detection by any optical means. Nor do they tend to drag it about. All known lines of mechanical force reach from atom to atom, they never terminate in ether; except, indeed, at an advancing wave front. At a wave front is to be found the reaction of a mechanical pressure of radiation whose other component rests on the source. This is an interesting but essentially non-statical case, and it leads away from our subject.

As to the nature of an electron regarded as an ethereal phenomenon, it is too early days to express any opinion. At present it is not clear why positive electrons should cling so tenaciously to a group, while an outstanding negative electron should readily escape and travel free. Nor is the nature of gravitation yet understood. When the electron theory is complete to the second order, or some higher *even* order, of small quantities, it is hoped that the gravitative property also will fall into line and form part of the theory; at present it is an empirical fact which we observe without understanding; as has been our predicament not only since the days of Newton but for centuries before.

Attention has hitherto been chiefly concentrated on the freely-moving active negative ingredient—the more sluggish positive charges are at first of less interest—but the behavior of electrons cannot be fully and properly understood without a knowledge of the nature and properties of the positive constituent too.

The positive electron has not, so far as I know, been as yet observed free. Some think it cannot exist in a free state, that it is in fact the rest of the atom of matter from which a negative unit charge has been removed; or, to put it crudely—that "electricity" repels "electricity," and "matter" repels "matter," but that Electricity and Matter in combination form a neutral substance which is the atom of matter as we know it. Such a statement is an extraordinary and striking return to the views expressed by that great genius, Benjamin Franklin. On any hypothesis those views of his are of exceeding interest, and show once more the kind of prophetic insight which we have had occasion to notice in discoverers before. Undoubtedly we are at the present time nearer to the view of Benjamin Franklin than men have been at any intervening period between his time and ours.

The view that an atom is composed of an equal number of interleaved or inter-revolving positive and negative electrons—to which it will have been observed I myself tentatively and provisionally incline—that view is not Franklin's; nor is it as yet anything but a guess. To make it more, work must be done upon the nature and properties of the positive charge; and the positive electron, if it exists, must be dragged experimentally to light.

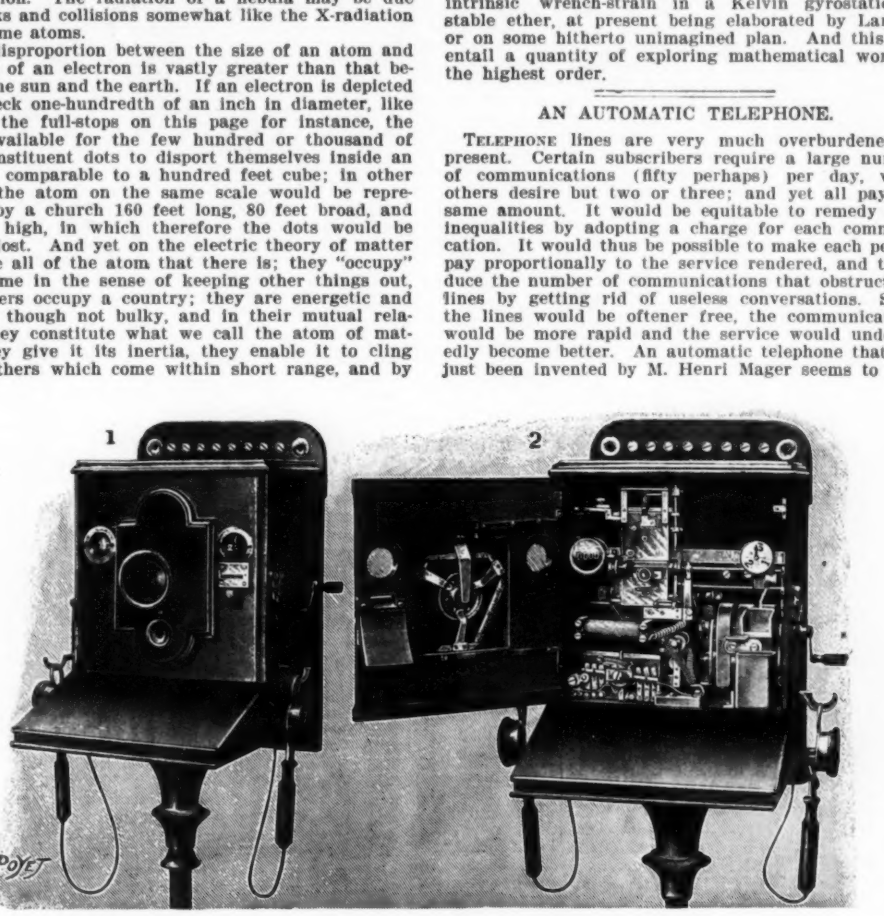
Especially must the inner ethereal meaning both of positive and negative charges be explained; whether on the notion of a right-and-left-handed self-locked intrinsic wrench-strain in a Kelvin gyrostatically-stable ether, at present being elaborated by Larmor, or on some hitherto unimagined plan. And this will entail a quantity of exploring mathematical work of the highest order.

* Cf. Rayleigh, British Association, Belfast, 1902.

* Fitzgerald and Trouton, Brit. Assoc. Reports, 1886, 1887, 1888.

AN AUTOMATIC TELEPHONE.

TELEPHONE lines are very much overburdened at present. Certain subscribers require a large number of communications (fifty perhaps) per day, while others desire but two or three; and yet all pay the same amount. It would be equitable to remedy such inequalities by adopting a charge for each communication. It would thus be possible to make each person pay proportionally to the service rendered, and to reduce the number of communications that obstruct the lines by getting rid of useless conversations. Since the lines would be oftener free, the communications would be more rapid and the service would undoubtedly become better. An automatic telephone that has just been invented by M. Henri Mager seems to lend itself very readily to the conditions required by the substitution of a charge per call for the subscription system.



1. External view. 2. Internal view.

MAGER'S AUTOMATIC TELEPHONE.

Of the accompanying figures, the one to the left gives an external and the one to the right an internal view of the apparatus. The latter, as may be seen, consists of a box of small size mounted upon a pedestal. In front is placed a desk upon which to rest the elbows; in the center of the upright is the telephone transmitter; on the left is an aperture in which appear the figures of a counter that records the number of calls; and on the right are a slot for the introduction of a coin and a counter of three minutes—the time that the conversation is to last. Upon the sides are placed the telephone receivers and a handle for turning the magneto that calls the central office.

The person who wishes to telephone gives the handle several turns, and the central office answers. He then asks for the number of the person with whom he wishes to converse. As soon as his correspondent has answered, the operator notifies him of the fact. He then introduces the proper coin into the slot, and it is thereupon possible for the telephone to operate. We cannot enter into the details of all the operations in this place, but shall merely mention them briefly. The coin, after being introduced into the slot, falls on to the pan of a balance and displaces a needle which disengages a motor apparatus. The latter, which may be a clockwork movement, begins running, and, through cams, the circuit of a source of electricity is closed upon a relay. A vibrator which is actuated strikes against the disk of a transmitter and notifies the central office that the charges have been paid. The operator thereupon makes the proper connection. When the clockwork is in operation, it acts upon a cam that forms part of a toothed wheel which makes but a single revolution per message. After the latter has made such a revolution, the cam bears against the extremity of a lever and allows the lever, which serves as an armature, to fall back at rest upon a regulating screw. The clockwork movement includes an eccentric toothed wheel, which, through its rotary motion, bears once in every three minutes' revolution upon the extremity of the lever of the arresting tooth, with which the arm of the balance has become engaged at the moment of the

introduction of the coin. The lever of the balance, having become disengaged, falls back to its starting point, and the needle, displaced at the outset, abutting against the regulator, arrests the motor. Communication is thus established for three minutes, and interrupted after such lapse of time. A new introduction of a coin at the end of three minutes permits of prolonging the conversation for three minutes more.

At every revolution of the motor, that is to say, for every message, a connecting rod arranged for the purpose actuates the counter that records the number of communications. The conversation may last as long as may be desired. All that is necessary is to renew the payment before the expiration of the three minutes.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

INTENSIFICATION AND REDUCTION.

IT often happens that either by the fault of incorrect exposure or development our negative is not by any means perfect for printing from, and in order to save it, and obtain a print giving us all correct gradations, after processes, either intensification or reduction, must be resorted to. If possible, we should always endeavor to obtain density in our negatives without resorting to intensification, as any process which is that of substitution, cannot be really permanent, although with cleanliness and copious washing between the various solutions, and afterward taking the precaution to varnish, will at least give us a negative which will last a reasonable length of time. Nearly everyone has a different opinion on the question of what the standard of density of a good negative should be. For instance, a man who does his printing by the platinotype process will have a different opinion on the standard of density to the man who does nothing but make lantern slides from his negatives; the silver printer from the carbon worker, and so on.

So that before exposing or developing we ought to have in our mind's eye what our negative is to be and what it is intended for. If it is to be printed in platinotype, the exposure should be correct and the developer strong, giving us a plucky, vigorous result; if for lantern work, the exposure should be full and the developer weak, the resulting negative being flat but full of detail, gradation, and half-tone. But supposing an occasion arrives and we require a print in platinotype from that negative, some method of strengthening the image will have to be resorted to, or the resulting print will be flat and muddy.

It very often happens that either from prolonged development or the use of a pyro developer which does not contain sulphite of soda, the gelatine film has become stained a yellow or greenish-yellow, and this stain, if not got rid of, will interfere greatly in our subsequent operations. There is also fog, either chemical or plain; this must be removed, because it must not be forgotten that any such fog or veil would be intensified to a result not to be by any means desired. Plain fog is easiest removed by well examining the dark slide, camera, lens opening, etc., for any stray light. Take the camera out in a strong light, place the cap on the lens, and after well covering your head with a large focusing cloth to exclude all light from the back. If any white light comes through the bellows or any other part of the camera, they should be stopped. Another frequent source of fogging arises from the blacking being worn off the inside parts of the camera and lens tube. This should be renovated at least once a year. An excellent dead black suitable for coating the inside of camera and lens can be made as follows: Dissolve shellac in methylated spirit, and add dry lamp black till the mixture is the consistency of thin cream. It should be applied with a small camel hair brush. Too much shellac must not be used, or the otherwise dead black will dry with a polish. Other sources of fogging are white light getting into the dark room and the ruby light not being safe. Now as to plates that have been fogged. These may be cured by placing in a slow-acting reducer. A very good formula is:

Sulphuric acid	1½	scr.
Hyposulphite of soda	8	ounces
Sulphite of soda	1	ounce
Chrome alum	3	drachms
Warm water	32	ounces

Dissolve the hypo. in 14 ounces of the water, the sulphite of soda in 3 ounces of the water, mix the sulphuric acid with 2 ounces of water, and pour slowly into the sulphite of soda solution; add the hyposulphite, and then dissolve the chrome alum in 8 ounces of water and add to the rest. The solution, when cold, is ready for use. The foggy negative should be placed in this solution and left till the shadows are clear. It should then be taken out and washed. Another method of removing the veil from off the negative is to immerse in the Howard Farmer reducer (which will be treated of later) till cleared.

Yellow negatives are best cleared in either of the following solutions:

Water	10	ounces
Alum	1	ounce
Hydrochloric acid	½	ounce

Soak the negative in water, immerse in the above solution till clear, and wash. The next clearing bath is the recently-introduced substance, thio-carbamide; and it should be noted that this substance only acts when the solution is distinctly acid in reaction. I have used it in the following manner with distinct success:

Thio-carbamide	1 drachm
Chrome alum	1 drachm
Citric acid	1 drachm
Water	10 ounces

This solution can be used repeatedly. Some negatives, however, in order to save much time and labor, are better reduced with the ordinary hammer before starting operations.

When it has been decided to resort to the intensification of a negative, certain preliminary precautions, it will be seen, are necessary, but more important than those mentioned is the fact that all trace of hyposulphite of soda must be absolutely removed, very thorough washing, followed if there is any doubt by immersion in either peroxide of hydrogen, 10 drachms of the 10 vol. solution to 5 ounces of water, soak for half an hour and wash; second, the alum and acid solution before mentioned for clearing yellow stain. This preliminary work is, I am afraid, neglected, with the result that intensification is often condemned while the real fault lies with the operator. We will now assume that the negative is ready for the actual intensifying processes, of which we have a considerable number to choose from, and in this connection it is amusing to note how one text book recommends one formula and the next book you get hold of condemns it. No wonder, then, that the mind of the beginner is as badly fogged as his plate may be. For our purpose to-night we may divide these intensification processes into three classes as follows: (1) The image is first bleached by the application of a certain chemical, while another chemical is employed to darken it again. (2) The image is darkened by the application of certain chemicals without previous bleaching. (3) The image, after being first bleached, is treated after the manner of an unexposed but undeveloped plate. This is called intensification by redevelopment.

In the first case, in which bleaching precedes the darkening of the image, the bleaching chemical perhaps most generally employed is mercuric chloride. We take:

Mercuric chloride	100 grains
Potassium bromide	100 grains
Water	10 ounces

or,

Mercuric chloride	5 parts
Hydrochloric acid	1 part
Water	100 parts

The reason of the addition of bromide of potassium to the mercury is that it counteracts the action of strong light upon the mercuric chloride, besides giving an additional sparkle to the negative. After bleaching in the mercury it has been suggested that the plate be immersed in

Common salt	1 ounce
Water	2 ounces

for a couple of minutes and well washed. It is said that this assists the removal of the mercuric solution from the film and gives a brighter and more sparkling result.

Place the negative, previously well washed and freed from hypo, in the mercury solution till it is bleached right and appears a white or grayish-white color on both sides, it is then again thoroughly washed, and is now ready for the darkening solution. There are a great number of methods employed to darken the image, but the majority of workers adopt some one of these darkening reagents for all purposes, and are either ignorant of, or indifferent to, the fact that by properly selecting our darkening reagents we can get a greater or less degree of darkening. In other words, we have open to us a choice of several degrees of contrast alteration. I will to-night treat of three darkening solutions, each giving a different degree of density.

First. If we have a fairly good negative which is nevertheless somewhat thin and produces a flat print, we may introduce the necessary sparkle by using sodium sulphite as the darkening chemical. If the bleached and thoroughly washed negative be placed in a 10 per cent solution of sodium sulphite acidified with citric acid till it is darkened through, again washed and dried, we shall attain our end. Should the density not be considered sufficient, the bleaching and darkening with sulphite may be done a second or even a third time. A similar agent to the sodium sulphite for this purpose is the recently-introduced acetone sulphite; it gives practically the same result and is used in a 20 per cent solution, and the bleaching and darkening can be repeated till sufficient density is obtained.

Second. A more pronounced effect is produced by the employment of ammonia, and this chemical was generally used, and is so still to a great extent. The bleached and well washed negative is immersed in a weak solution of ammonia, i. e., about 10 minims of the 0.880 solution to one ounce of distilled water, till it is darkened right through, and then washed again and dried.

Third. The next formula is the one known as Monckhoven's, and is the one I use in my general practice when I require great increase of density. The same strength of mercuric chloride is used as for the other methods, but the darkening agent is that of silver nitrate and cyanide of potassium. Authorities differ considerably in regard to this formula. Captain Abney has great faith in it, and recommends it in his instruction in photography. Mr. Bothamly says its only drawback is the use of the highly poisonous cyanide of potassium. Mr. Chapman Jones says this formula is unreliable, but I have negatives which were darkened by this formula five years ago, and although not varnished, they are perfect to-day. The formula is as follows:

No. 1.

Silver nitrate	100 grains
Water	10 grains

No. 2.

Cyanide of potassium	10 grains
Water	1 ounce

Dissolve in separate bottles and add No. 2 gradually to No. 1 till the heavy precipitate first formed is nearly but not quite dissolved. It is very essential not to have any excess of cyanide, otherwise after intensification a weakening action ensues. These then comprise the process of mercurial intensification so far as previous bleaching is concerned. We now pass on to the second division of our subject, viz., intensification without previous bleaching, and the first process that will engage our attention is that of the uranium method. This has long been a favorite with many amateurs, and its powers are not so generally known as they deserve. Either the nitrate or acetate of uranium can be used, but as the nitrate is the one generally stocked by the dealers, I will give a formula for it:

No. 1.

Uranium nitrate	100 grains
Water	3 ounces

No. 2.

Potassium ferricyanide	5 ounces
Acetic acid	3 drachms
Water	3 ounces

For use take equal quantities of 1 and 2. A simpler form of uranium intensifier is that lately brought out by the Bayer Company, and simply requires the addition of water to be ready for use.

Soak the negative in water and then place in the solution. Shortly the image turns a red brown color; although this does not look much stronger, yet the change in color has very considerable light stopping power. The negative now, without any further treatment, is washed till the greasy appearance of the film disappears. Take note that prolonged washing will remove all or nearly all the grain by intensification, also that any alkali such as soda or ammonia, also removes it.

The next single solution intensifier is simplicity itself. Dissolve 1 drachm bichloride of mercury in 7 ounces of water, and 3 drachms iodide of potassium in 3 ounces of water, and pour the iodide solution into the mercury.

Mercuric chloride	1 drachm
Potassium chloride	3 drachms
Water	24 ounces

When the iodide is first added to the mercury, a bright scarlet precipitate is thrown down, but as the full quantity is added it is re-dissolved. Now add 120 grains of sodium sulphite dissolved in 2 ounces of water. Place the negative in this solution till dense enough, after which it is washed for a few minutes under the tap; the color is now of a yellow brown, and if necessary we can darken it in any ordinary developer. The chief advantages of this intensifier are that it is not absolutely necessary to free the negative from hypo before proceeding to intensify, and it is also very suitable for pictorial workers, who can locally build up their negatives and be able to judge the exact time to stop without having to follow with another agent and so change the density. I have now, as much as the scope of a short paper will allow, enumerated the various forms of intensification in general use, for it is a subject that is little known by the average amateur; he has a certain dread of the process, but when once tried he will be surprised how simple it really is.

We now come to the third division of our subject, viz., the intensification by re-development. In this, as in all previous cases, the first step consists in the thorough removal of all traces of hypo by means of the acid solution of alum and thorough washing. The negative is then bleached in a saturated solution of mercuric chloride, to each ounce of which 10 minims of pure hydrochloric acid have been added. When thoroughly bleached and well washed the negative may be developed after the manner of a newly-exposed plate by most of the developers in common use. Amidol, metol, edinol, hydroquinone can be used, but perhaps ferrous oxalate gives the best result. In the first place, it is simple; and then, again, a considerable increase of density is obtained, because all the silver and mercury present in the film is left behind in the metallic state; and lastly, like the sodium sulphite method, it can be repeated over and over again till the necessary density is obtained. The solution used should be one part of a saturated solution of iron sulphate to six parts of a saturated solution of potassium oxalate; and it is essential that both solutions should be acidified with either sulphuric, acetic, citric, or oxalic acid. The previously bleached negative is allowed to soak in this till the image is blackened right through to the back, and is then washed. It is advisable to acidify the first washing water with acetic acid (as is done in developing bromide paper with ferrous oxalate), to prevent the precipitation of any iron salt. A process which goes hand in hand with intensification is that of reduction, for oftentimes, in order to obtain the proper scale of gradation in a negative it is necessary to reduce first and intensify afterward, so that, although not in the syllabus, it may not be out of place to give a short description of reducing methods.

REDUCTION.

To many amateurs the name of reduction is one to be dreaded, as there seems to be a general vagueness in most of the text books on the subject. But if we are attentive to details and use the right chemicals for the right purpose, the process of reduction will be very much simpler than that of intensification. As we have seen in the process of intensification we aim at increasing the light-stopping powers of a negative, and at the same time we wish to do this evenly. That is to say, we wish to increase the range of contrast by adding more material to the high lights than to the shadows. On the other hand, there are several kinds of negatives which call for reduction. We might classify them:

1. The negative may be correctly exposed, but development has been carried too far.

2. The negative is rather underexposed, and by prolonged development the contrasts have been greatly exaggerated.

3. The negative has been overexposed and also a long time in the developer. The resulting print is flat and the time of printing very long.

In the case of the underexposed and strongly contrasted negative, we require a reducer which attracts high lights without touching the shadow detail; and in the case of the flat, thick negative, we first reduce so as to increase contrasts slightly, and then subsequently intensify in order to build up printing contrasts.

Thus it will be seen that as we recognize the nature of the disorder, so we must adjust our treatment. We shall confine ourselves to-night to the consideration of two reducers which fulfill practically all our requirements. First, perhaps the best known of all reducers, namely, the Howard Farmer, or ferricyanide of potassium method. We make up two solutions as follows:

A.

Saturated sol. pot. ferric. (red pruss., not ferroc.)

B.

10 per cent solution of hypo.

To reduce, take 2 ounces of B and add to it two or three

drops of A and pour over the plate, rock gently and rotate the action carefully. Be content to go slowly, and use as little ferricyanide as you can, the less the better, as with some brands of plates there is a tendency to stain the film. The negative should be withdrawn just before sufficient reduction has taken place, and well washed. This is the reducer to use for a negative described as flat and dense, as it has the properties of attacking the shadows before the highlights, and if used for a harsh negative we would be simply exaggerating our contrasts and make the evil greater than before.

Recently a new agent has been introduced, namely, ammonium persulphate. Some difference of opinion at present exists as to its correct formula and what happens when a solution of it is made in water, and also its action on the bromide of silver film. These points do not concern us, as so long as we obtain the wished-for result we need not enter into argument on these points. The salt is now an article of commerce and is obtained from any photographic dealer. In appearance it is of a white crystalline powder. The most convenient strength to use it is

Water	5 ounces
Ammon. persul.	1 drachm

The salt easily dissolves. If when dissolving the bottle be held close to the ear a curious crackling sound is heard. The negative must be thoroughly freed from all traces of the hypo, or brown stains will result. If we wish for a more energetic solution we can use

Persulphate of ammonia........	½ ounce
Sulphuric acid	10 minims

and ten ounces of a nearly saturated solution of alum. The acid arrests the action and the alum counteracts any tendency of the film to frill, which often happens when the persulphate is used strong. The negative when placed in the reducing bath does not at first show any effect, but action soon begins and proceeds steadily. The plate should be withdrawn as soon as the correct density has been arrived at, and immediately placed in a ten per cent solution of sulphite of soda, which stops any further action of the reducer. The first negative I reduced by this method I omitted this precaution, and after reduction placed the negative under the tap to wash. When I came to put it to dry there was no image left, only a brown stain; reduction had been proceeding while the negative was washing.

The great point about this reducer is, besides being simple and clean, it tends to reduce contrasts as well as reduce density, and hence is of especial value in the case of a negative rather underexposed and over-developed.

Not very long ago a salt was introduced under the name of anthion as a specific for the elimination of hyposulphite of soda from the negative. This is closely related to ammonium persulphate, and is in fact potassium persulphate. It may in a like manner be used as a reducer, but it possesses no advantages over the ammonium persulphate, besides being more costly and less soluble in water. I have now, gentlemen (as much as the scope of a short paper will allow), enumerated the various forms of intensifiers in general use, for the process is one little known by the average amateur, who has a certain dread of the process, but when once tried he will be surprised how simple it really is.—The British Journal of Photography.

ON THE PERFORMANCE OF THE PNEUMATIC RETARDING DEVICE OF PHOTOGRAPHIC SHUTTERS.*

By EDWARD W. MORLEY, Ph.D., LL.D., and DAYTON C. MILLER.

WE have made some experiments to learn what degree of accuracy and constancy are to be expected from the pneumatic retarding device used with photographic shutters. The sector shutter of Goerz and the volute shutter of Bausch & Lomb are so constructed as to promise the best performance of any on the market, and we procured for our use two of each of these shutters. Simple observation showing less uniformity in their action than had been expected, we were led to set up an apparatus with which the times given by each setting of these shutters could be accurately measured by readings made on permanent records. The results may be of interest to others.

The time spent in opening and closing, as well as the whole time of exposure, were determined by a modification of the method used by Abney. It will be remembered that he photographed, on a moving plate, the image of the shutter in the act of opening and closing. Before the camera containing the plate was placed the shutter to be measured, the plate and shutter being in the conjugate foci of the lens of the camera. In contact with the shutter was a horizontal slit, so adjusted as to become a diameter of the circle formed by the opening of the shutter. Suppose the plate to be in motion; at each instant, there is formed on it the image of that part of the slit which is at that instant uncovered by the shutter. On the whole photograph we shall see, first, a widening triangle corresponding to the process of opening; then, a parallelogram answering to the period of full opening; and, lastly, a narrowing triangle showing the process of closing. In Fig. 1, if the plate moved in the direction shown by the arrow, *a* is the beginning of the record, *ab* shows the time used in opening, ten or twelve thousandths of a second; *bc* shows the time of full opening, twelve-thousandths; and *cd* shows the time used in closing, seventeen-thousandths.

To measure these times, Abney interrupted the light passing through the shutter by means of a rapidly-revolving wheel; and the passage of each spoke before the shutter caused a blank in the photographic negative, whose appearance is shown in Fig. 2. The dark lines are successive images of the slit, while the white spaces indicate the periodic cutting off of the light. If the interruptions occurred at the rate of two hundred and fifty in a second, the dark bands are photographs showing how much of the slit was uncovered at successive two-hundred-fiftieths of a second, and by counting on this scale, we can determine the length of the whole exposure, or of some definite part of the whole exposure.

In our measurements, we interrupted the light by means of tuning forks kept in uniform vibration by a suitable electrical attachment. In some cases, the whole light falling on the slit was cut off, in which case the photograph had the appearance shown in Fig. 2. In other cases, the light falling on the central portion of the slit was interrupted, but not that falling near its ends, and the photographs obtained were such as shown by Fig. 3.

With this apparatus, we measured the times given the four shutters mentioned, as well as those given by a volute and a sector shutter lent to us by friends. One sector shutter was also measured in the inverted position in which it was attached to the pocket camera of our friend. Each shutter was measured repeatedly for all exposures not over half a second. By comparing the average for one shutter with that for the same setting of another shutter, we learned the accuracy with which shutters agree with the professed times, and with each other. By comparing the individual measurements for the same setting of a given shutter, we learned the accuracy with which the setting repeats a desired time of exposure.

I. Each shutter opens in less than four-thousandths of a second. The volute shutter brings two springs into action for short exposures, and its time spent in closing varies; Fig. 2 shows the two times, which are about eight-thousandths for longer exposures, and four-thousandths for the shortest exposures. The sector shutter always closes in the same time, which is less than three-thousandths of a second, as shown in Fig. 3.

II. The accuracy with which the average time given

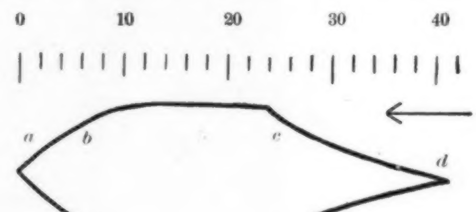
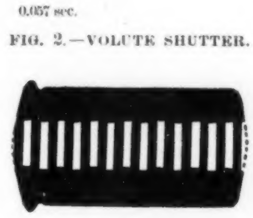


FIG. 1.—IRIS DIAPHRAGM SHUTTER SET FOR 1/50 SECOND.

0.057 sec. 0.009 sec.

FIG. 2.—VOLUTE SHUTTER.



0.036 sec.

FIG. 3.—SECTOR SHUTTER.

COMPARATIVE DIAGRAMS OF THREE DIFFERENT SHUTTER SPEEDS.

by a shutter answers to the time marked on it is shown by Table I.

TABLE I.

Time by scale.	Average actual time three volute shutters.			Time by scale.	Average actual time three sector shutters.		
	1	2	3		4	5	6
sec.	sec.	sec.	sec.	sec.	sec.	sec.	sec.
1/150	0.006	0.007	0.009	1/150	0.011	0.007	0.010
1/100	0.008	0.009	0.009	1/100	0.011	0.011	0.013
1/50	0.010	0.009	0.009	1/75	0.054	0.014	0.024
1/25	0.045	0.067	0.064	1/20	0.076	0.043	0.062
1/5	0.222	0.200	0.109	1/10	0.107	0.1[illegible]9	0.103
1/2	1.14	0.33	0.23	1/5	0.207	0.299	0.203
				1/3	0.36	0.44	0.36
				1/2	0.46	0.67	0.54

The average deviation of the actual time from the professed time is a little more than thirty-five per cent.

III. To determine with what accuracy a given setting of the same shutter reproduces the same time of exposure, we measured each setting three times and noted the difference between the longest and the shortest exposures. There were ten such sets of three for the volute shutter, and twenty for the sector shutter. Table II. gives the number of sets for each shutter in which this difference had the values indicated.

TABLE II.

Number of cases in which the difference had certain values.

	Volute shutter.	Sector shutter.
Less than 20 per cent	0	11
20 "	3	3
25 "	1	
30 "	1	3
35 "	1	2
40 "	1	1
50 "	2	
80 "	1	

For the sector shutter, the difference between the shortest and longest exposure out of three is as much as twenty per cent in nine cases out of twenty; for the volute shutter, the difference was as much as twenty per cent in all cases.

IV. The sector shutter is sometimes applied to small cameras in an inverted position. Table III. shows the nominal times and the actual times for the shutter which was lent to us so adjusted.

TABLE III.

Times given by sector shutter in two positions.

Time by scale.	Average actual time, piston up.	Average actual time, piston down.
sec.	sec.	sec.
1/150	0.010	0.007
1/100	0.012	0.011
1/75	0.013	0.014
1/20	0.014	0.043
1/10	0.064	0.139
1/5	0.197	0.290
1/3	0.400	0.443
1/2	0.493	0.667

It is obvious that in some cases the difference in the times given in the two positions is enough to occasion disappointment unless taken into account.

V. The volute shutter can be set to give exposures longer than half a second. Table IV. gives the measured times given by these settings.

TABLE IV.

Long exposures of the volute shutter.

Time by scale.	Actual time.		
	1	2	3
sec.	sec.	sec.	sec.
1	1.25	0.52	0.36
2	1.80	0.90	0.72
3	4.80	1.23	1.23

Some of the conclusions justified by our experiments may be stated.

1. It is difficult to see the advantage of the automatic timing of exposures longer than half a second. Not many would fail, after half an hour of tuition or trial, in making by hand exposures more accurately timed than those of Table IV.

Our further conclusions depend on the time which the amateur demands for his shortest exposure. That which we devise when the fiftieth of a second is short enough is very different from that which commends itself to us when the same shutter must give exposures of less than a hundredth of a second as well as exposures between the tenth and the fiftieth of a second.

2. When the fiftieth of a second is sufficiently short, we think it better to use a shutter having no pneumatic retarding device, but giving two or three different times by varying the tension of a spring or by calling reserve springs into play for shortening the time. Good shutters of this kind are much used on certain forms of camera. They are not diaphragm shutters, it is true; but the shutter acts between the components of the lens, and the result cannot be distinguished from that given by the diaphragm shutter. These shutters, at least some of them, give the times of exposure which are most commonly serviceable, and they give them with unfailing accuracy. One such we measured at one of its velocities forty-two consecutive times, and there was no variation greater than five per cent. Another we measured sixty times, at its three velocities, which were 0.031, 0.025, and 0.022 seconds. There were but two cases in the sixty where the variation was as much as ten per cent.

With this constancy of time of exposure, we may compare the results of similar repeated measurements of those two shutters out of the six mentioned above which were selected as the most accurate. We set these one hundred twenty-five times for an exposure of the twentieth of a second. The times actually found varied from fifty-five per cent less to thirty-seven per cent greater; in more than half the exposures, the variation from the average was more than twenty per cent.

We are inclined to urge that this form of shutter ought to be developed and improved. It would not be difficult, by bringing into play either one spring, or two or more springs, at will, to increase the longer time given by it to a fifteenth or twentieth of a second. An exposure of half a second can be easily and accurately given by hand, after no long practice, with more accuracy than by the pneumatic retarding device. Exposures of a third or a fifth or a tenth are harder to give with accuracy; until one has learned to do so, he must make the time half a second and use a smaller stop. The amateur who uses such a shutter will have at command, with all desirable accuracy, the most frequently useful times of exposure, from a fifteenth to a fiftieth of a second.

3. When the shutter which gives these times must also be capable of giving times as short as the hundredth of a second, our advice is different. The pneumatic retarding device is, at least for the present, inevitable, and we recommend a certain modification in it.

The pneumatic device occasions the greatest uncertainty in those exposures which call for but a slight retardation. Times such as the twentieth, thirtieth, and fiftieth, are included within this region of greatest uncertainty. It seemed to us not unlikely that, if the piston were made to move with so much less friction and air resistance that the whole retardation were reduced to a tenth of a second, this region of greatest uncertainty might be removed from the desired exposures of a twentieth and a fiftieth of a second to some shorter exposure where it might do no harm. We accordingly made new pistons for that one of the two selected shutters which was the less accurate of the two. One of these gave an exposure time of 0.056 second when set at one-half on its former scale. Table V. gives the marks of the former scale, new times which might be marked at the same points, the average times given at these settings, and the greatest variation from the new average times.

With this shutter as at present readjusted, we can give exposures of the one-hundred-and-fiftieth of a second; we can give the most frequently used expos-

* Paper read before the Winter Meeting at Washington, D. C., of the American Association for the Advancement of Science.

TABLE V.

Times and variation of times of readjusted shutter.

Former scale. sec.	Proposed scale. sec.	Average times. sec.	Greatest variation. Per cent.
1/2	1/18	0.056	4
1/3	1/23	0.044	4
1/5	1/31	0.032	4
1/10	1/45	0.022	5
1/20	1/80	0.012	20
1/75	1/100	0.010	
1/100		0.009	
1/150		0.007	

ures from the forty-fifth to the eighteenth of a second with an accuracy amply sufficient, and we can give exposures of half a second or longer by hand. Until considerable improvements in design and workmanship shall make the pneumatic retarding device much more trustworthy than at present, this is the practice which commends itself to us. If others should come to the same conclusions manufacturers would be led to make retarding devices to give only exposures not longer than a tenth of a second, but giving them with accuracy, and leaving to the operator the timing of all longer exposures.

PAINTING BY THE ACRE.*

The average houseowner who paints his dwelling once in five years considers that he is discharging his whole duty in the direction of keeping up appearances, although there are fastidious persons who insist upon a fresh coating as often as every third year. In fact, there may be found a few instances of men—regarded in their own neighborhoods as slightly unbalanced mentally—who redecorate the exterior of their dwellings every year.

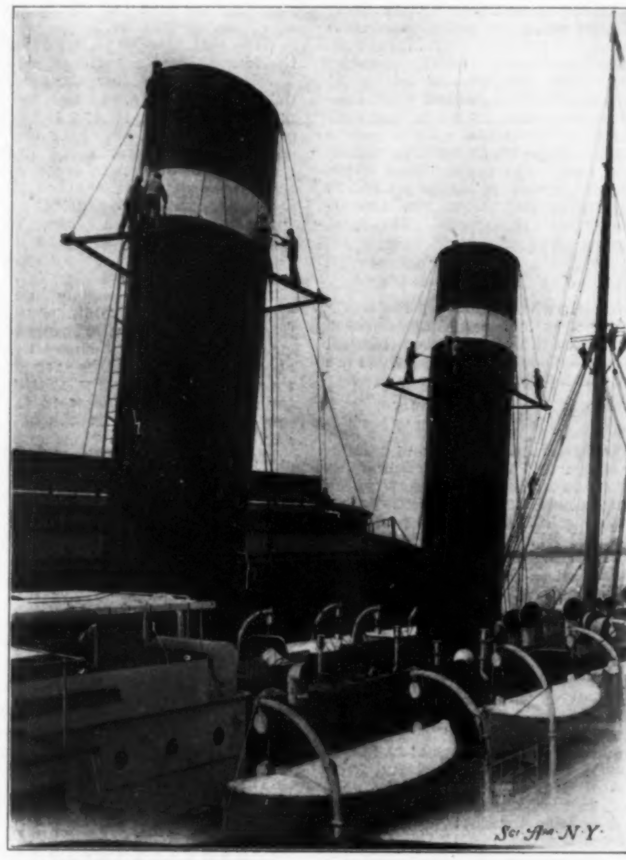
But what would be the feelings of the householder who complains of the trouble and expense of this infrequent process if he unexpectedly became the owner of an ocean liner? When he learned the requirements necessary to keep his great floating palace in presentable dress, his first impulse would be to apprentice himself to the painters' union. If the modern Atlantic flier is a glutton for coal, she is no less a glutton for paint, and her bills on this account in the course of a year amount to as much as the salary of the average bank president.

Under ordinary circumstances the ships of the largest and most carefully managed lines are painted at the end of every voyage. Take, for example, one of the American Line steamers, as the "St. Paul" or the "New York," running between New York and Southampton. Every time one of these ships arrives in New York she is repainted. And this is no patchwork undertaking, like covering up bald spots here and there. Every inch of the vessel's outside area above the water line—sides, deckwork, funnels—from stem to stern is carefully gone over and receives a complete fresh coating. As the vessel makes from ten to fifteen round trips in the course of a year, this means that they are entirely repainted, except as to interiors, an equivalent number of times. And the painting of the interior woodwork—saloons, staterooms, storehouses, and all her hundreds of compartments—is renewed whenever the vessel is given a complete overhauling, which occurs ordinarily once a year.

When one contemplates the great size of the modern passenger ship and figures the extent of her area, he does not need to be told that this represents in the aggregate a vast undertaking for each of the big steamship companies. The sides of the average first-class liner from water line to rail represent an area of about an acre. The outworks of decks and cabins amount to almost as much more, while the outside surface of the giant's two great funnels and her masts totals over half an acre. Thus there is an area approximating two and a half acres to be covered on the biggest liners at the end of every round trip voyage.

There are 140 steamers in the International Mercantile Marine Company alone, which includes of course the largest of all passenger fleets. Assuming that the average area to be painted on these ships is two and a quarter acres, and that each vessel makes only ten round voyages in the course of a year, and that one hundred of the ships are continually in commission, the big shipping combination still has as one of its duties the painting of some 2,250 acres each year. This is a job which would require the services of nearly one hundred men working steadily, and of course it would consume hundreds of thousands of gallons of paint. Its cost, while among the minor expenses in the operation of the company, must be between a quarter and a half million of dollars a year.

* Specially prepared for the Scientific American Supplement.



ADJUSTABLE SCAFFOLD FROM WHICH THE SMOKE-STACKS ARE PAINTED.

This seems an immense sum to expend for the single item of paint, but its expenditure is essential to the preservation and the presentability of the great steamers. There are two very obvious reasons why the Transatlantic flier is refurbished so frequently. One is to prevent corrosion of her metal work; the other is to keep her always spick and span in appearance. The spray of the salt sea waves is much more destructive to paint than ordinary land weather, while it is an accepted doctrine among all steamship managers that their vessels must be bright and shining whenever they leave port if they are to hold the favor of the traveling public.

The greatest enemy to the beautiful whiteness in which the steamer's upper works are usually resplendent is the soft coal burned in the furnaces. The dust and cinders from this coal are fairly ground into the paint in the course of a voyage, so that it is almost impossible to remove the former without taking off the latter. A thorough scrubbing is always necessary before the painting operations actually begin, and sometimes, indeed, this serves the purpose so well that it is not necessary to repaint the deckwork entirely oftener than every other voyage.

As soon as the liner is in her berth and the passengers ashore, the work of the painters begins. A force of from twenty-five to thirty is maintained by each of the large companies as a part of the regular "onshore" crew. The funnels present the most difficult and also one of the most important tasks, and work on them is started without delay. The giant smokestacks of a great liner, often large enough to run a double line of trolley cars right through them, are so heavy and massive that one would hardly believe that they could be injured by anything the workmen (who look like particularly large flies swung against them on their lofty stagings) might do. As a matter of fact, however, these great pipes are particularly susceptible to injury and must be handled very carefully. Any pounding or hammering against them would cause holes to appear, and after that they would go to pieces in short order. The old paint and the dirt must be carefully scraped and scaled off before the actual painting begins, and this is really the more difficult part of the task. The work of actually applying the paint moves rapidly, as the surface is a broad and unbroken one, and the paint is mixed thin and put on with big brushes.

While this is in progress another group of painters is busy with the steamer's towering sides. They work from floats or from stagings suspended from the rail, and are armed with broad, long-handled brushes like those that bill-posters use in covering dead walls with paste. The amount of space that one of these men will cover in the course of a day is astonishing to a person familiar only with the more deliberate methods of land workmen. The paint used in this marine work is of special preparation, and contains a large proportion of oil. It is spread very thin, moreover, since otherwise the steamer's sides would be badly gummed in a short time from the frequent coatings.

The deckwork, although in some respects less difficult than the painting of either the sides or the stacks, proceeds more slowly, as the preliminary scrubbing must be more thorough, the surface is more broken, and the operation must be carried on without interfering with the other activities of the ship. Most of the liners have their deckwork painted white, their sides black, and their stacks of some light tint with a distinguishing band around them—so that altogether four colors are usually employed in covering a vessel.

Nearly all the painting of the great Atlantic fliers is done on the American side for a reason that is pertinent enough, although it might not occur to the ordinary observer. This reason is found in the weather conditions. There is a much larger proportion of fair days in the United States than in England or the Continental ports. Consequently nearly all the Transatlantic lines, whether or not they have their headquarters in the United States, have their painting done in American ports. Thus it is that whenever one visits a liner in this port between voyages, one is likely to see men slung aloft painting the funnels, men on floats painting her lower sides, other men hanging from the rail painting the upper portions of her sides, and still others on deck with tarpaulins spread all about painting every inch of exposed space.

PAINTING THE TOPSIDES OF AN OCEAN LINER IN PORT.

THE GARUTI PROCESS OF GENERATING OXYGEN AND HYDROGEN.*

By EMILE GUARINI.

FOR more than a century scientists have endeavored to apply oxygen and hydrogen to various industrial uses. But the difficulty of generating the gases in an economical way has to a large extent prevented the realization of this idea.

No doubt the most familiar method of generating the two gases simultaneously consists in electrolytically decomposing water. But theoretically the decomposition of water by the electric current, which seems fully to answer all requirements, is, nevertheless, of no commercial value. The experimental apparatus is simple enough; but the difficulties encountered in a commercial installation are almost insuperable. Two essential conditions must be realized; the one, reduction to a minimum of the electromotive force, the other, perfect separation of the two gases.

In order to realize the first condition, it is necessary to determine exactly the most suitable composition of the electrolyte, that is, the liquid to be decomposed. Furthermore, the same device must be used by which the two electrodes can be adjusted toward and from each other. In order to fulfill this second condition, it is necessary to place a diaphragm between the electrodes. The circulation of the electrolyte being necessary to insure continuity of operation, the diaphragm should be permeable to the liquid. But in order to insure the separation of the gases, the diaphragm must be impermeable to them. Consequently, it becomes necessary to devise a diaphragm permeable to liquids, but impermeable to gases, and a good conductor of electricity. Diaphragms of every possible substance have been used; all in vain. Renard, Latchinov, Schuckert, Schmidt, and Flament used diaphragms of porcelain, pipe-clay, carbon, and the like. But the great electrical resistance, the impossibility of preventing the gases from mixing with the liquid, structural difficulties, and cost of maintenance prevented a commercial realization of their ideas.

An Italian physician, Dr. Pompeo Garuti, conceived the idea of using a metallic diaphragm, which *a priori* seemed to be impossible of success. If a plate of metal be placed between two electrodes, it will be electrolyzed by influence, the positive electricity flowing over the face opposite the negative electrodes and negative electricity flowing over the face opposite the positive electrode. The metallic diaphragm is nothing more or less than a bipolar electrode; consequently, in each compartment, there must be produced simultaneously hydrogen and oxygen, that is to say, an explosive mixture.

Garuti has proven that this phenomenon will not be produced if the electromotive force of the current does not exceed three volts and if the intensity is not more than two amperes per square decimeter of the electrodes.

The small resistance of the diaphragm renders it possible to carry out the process of electrolysis with a difference of potential less than three volts.

The rest of the problem is simply to provide a means for the sure circulation of the electrolyte. The better the circulation, the less will be the resistance. The position which gave the least resistance was found to be that in which the lower extremity of the diaphragm did not descend below the electrodes. But the gases mixed. In order to avoid such a mixture the diaphragm must be lowered, which in turn entailed an increase of resistance.

The difficulty thus presented has been avoided by perforating the metallic diaphragms. These perforations have a diameter of one millimeter. They allow the electrolyte to pass through, and are but slightly permeable to the gases.

The problem of providing a suitable diaphragm having been solved, the inventor now sought to devise a suitable cell. After many experiments a cell was adopted which consists of a series of smaller cells inclosing each an electrode, and composed of sheets of soft steel soldered together so that th joints would be all liquid-tight. The electrolyte consists of a solution of caustic soda or potash. The cells are placed side by side and are open below and partially open above. The left half of each cell inclosing an anode is open; and the right half of each cathode cell is also open. A bell, covering the left half, collects the oxygen; another bell, applied to the right half, receives the hydrogen. When the apparatus is large the diaphragms and the electrodes are held rigidly in place by means of wooden cones placed at the lower part.

Apart from the wearing away of the anodes, which must be renewed at the end of three years, the Garuti apparatus suffers no change by usage. The cost of maintenance is, therefore, very small. The only care that the cells require is filling each day. The concentration of the soda solution should be 25 per cent. A very dense solution facilitates the generation of gas and obviates the passage of the bubbles through the perforations of the diaphragm. Furthermore the greater the density, the greater will be the velocity of ascension of the gas.

For the sake of safety the gas should be frequently analyzed. Analysis can easily be made by means of the Hemple apparatus, or the Bassani electric densimeter based upon Graham's law of the flow of gases, or with Winssinger's densimeter, which is an aerostatic balance.

One coulomb of current will free 0.0829 milligramme of oxygen and 0.703 milligramme of hydrogen, or 0.058 cubic centimeter of oxygen and 0.116 cubic centimeter of hydrogen at a temperature of 0 deg. Centigrade and a pressure of 760 millimeters. Under the same conditions, in one ampere hour there will be released 208.8 cubic centimeters of oxygen and 417.6 cubic centimeters of hydrogen. Since the temperatures are as a general rule 18 to 20 degrees Centigrade, it can be said that an ampere hour will free 0.4 liter of oxygen and 0.2 liter of hydrogen.

In order to ascertain the theoretical electromotive force required, Thompson's rule can be employed, according to which rule, the heat generated by the formation of water is equivalent to the electric work necessary for decomposition. One gramme of water releases about 3.8 calories or $3.8 \times 425 = 1{,}615$ kilogrammes. One coulomb will decompose 0.00009333 gramme of water. To decompose one gramme of water, work must be performed equivalent to

$$\frac{1}{0.0000933} = C \times x \text{ volts};$$

or in kilogrammes

$$\frac{1\,x}{0.0000933 \times 9.81}$$

Hence we may write

$$\frac{x}{0.0000933 \times 9.81} = 1615$$

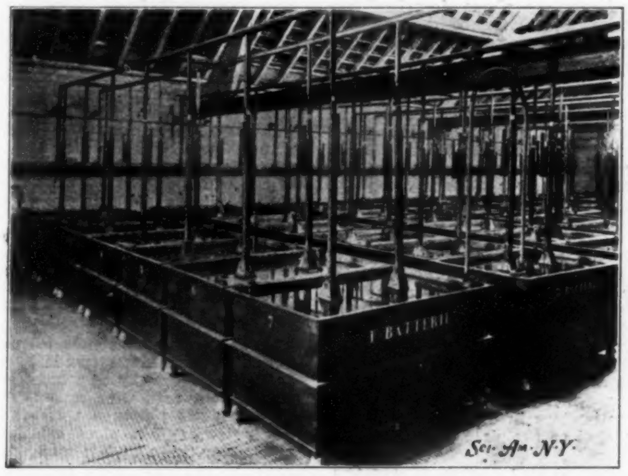
from which it follows $x = 1{,}615 \times 0.0000933 \times 9.81 = 1{,}488$; or in round numbers 1.5.

Theoretically, the electromotive force may therefore be considered 1.5 volts. Practically, this figure cannot, of course, be realized. From a calculation made by M. Eric Gérard, a Garuti electrolyzing apparatus constructed of sheet steel and containing the best caustic potash required an electromotive force of 1.988.

In actual industrial practice it would not be possible to reach so high a figure with a lower grade electrolyte, which costs somewhat less, but offers somewhat more resistance. The average electromotive force obtained under these conditions with such an electrolyte would be 2.4.

With this maximum voltage, and allowing for a production of 0.4 liter of hydrogen and 0.2 liter of oxygen per ampere hour, the production per kilowatt hour would be 166.6 liter of hydrogen and 83.3 liters of oxygen, or in all 290 liters of oxyhydrogen gas. The production of 1 cubic meter (35.315 cubic feet) of this gas (666 H and 333 O) therefore requires 4 kilowatts. A cubic meter of hydrogen requires 6.25 kilowatts, and 1 cubic meter of oxygen 12.5 kilowatts.

A company has been formed not only for the purpose of exploiting the Garuti process, but also for manufacturing special implements for the utilization of oxyhydrogen gas.

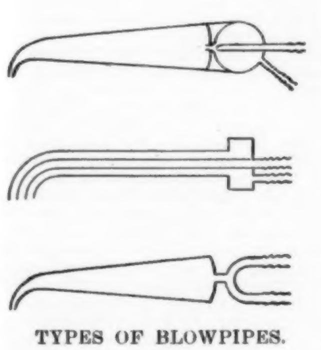


A GARUTI INSTALLATION FOR THE ELECTROLYTIC PRODUCTION OF OXYGEN AND HYDROGEN.

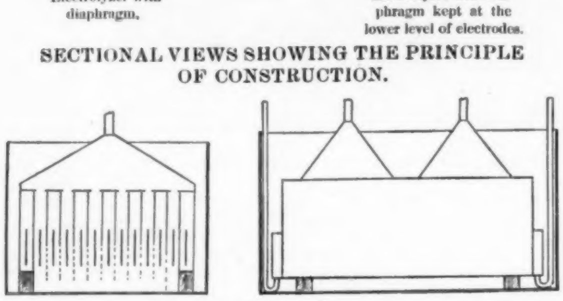
Electrolyzer with diaphragm.

Electrolyzer with diaphragm kept at the lower level of electrodes.

SECTIONAL VIEWS SHOWING THE PRINCIPLE OF CONSTRUCTION.

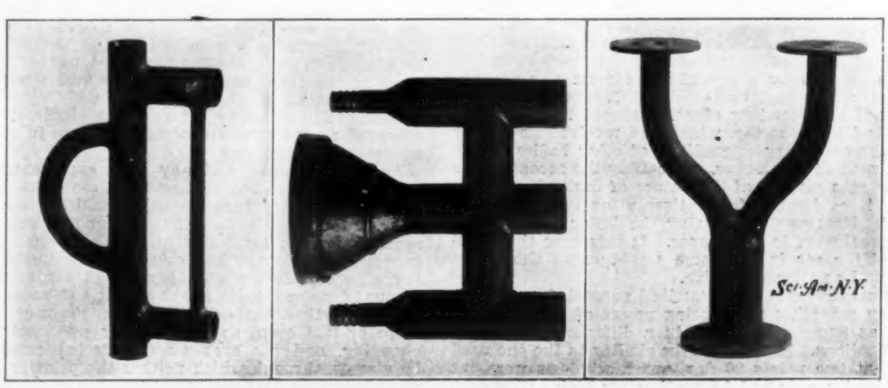


TYPES OF BLOWPIPES.



DIAGRAMS ILLUSTRATING THE GARUTI ELECTROLYTIC APPARATUS.

SOLDERING WITH OXY-HYDROGEN BLOWPIPE.



VARIOUS FORMS OF OXY-HYDROGEN BLOWPIPES.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

ON THE PROPERTIES OF THE FIELD SURROUNDING A CROOKES TUBE.*

By ARTHUR W. GOODSPEED.

THE investigation of the subject implied by the title of this article was suggested by the unexpected presence on some radiographic records of peculiar markings outlining certain bodies *below* the plate, in addition to the expected shadows of the objects above the plate—i. e., between the sensitive film and the vacuum tube.

While using an iron tripod stand with a ring-shaped top as a support for a radiographic plate, it was noticed that the plate when exposed to X-rays seemed to be influenced locally by the presence of the iron ring below. For after exposing a circular piece of bronze placed on the upper side of the plate which had rested on the stand during exposure, the development showed that just above the metal of the stand the plate was appreciably less affected through the bronze than under that portion of the latter which had not been over the metal support. This startling observation suggested at once more careful investigation, especially since on first thought it would seem that if the metal below the plate could have any effect, the result should be quite the contrary to what was observed—i. e., if the metal below sends off "emanations" of some sort which might produce an effect on the sensitive film, the latter would be expected to show an increased density where influenced both by the rays from above and by the emanations from beneath.

Apparent anomalies have on several occasions been noticed on radiographic plates, some similar to that just mentioned, but these have never been definite enough to invite special investigation.

A large number of experiments were made at once in rapid succession with strips and plates of various substances both below and above the sensitive film, with results always the same in character though differing in intensity of effect in different experiments and with different materials. As examples of the character of some of the tests, sheets of paraffin, mica, and of aluminium were successively placed between the under metals and the film, with the result that the effect in every case was similar, only a little less intense than when no screen was interposed. The original records of all these experiments and the particular conditions in each case have been carefully preserved.

Remarkable results were obtained when two zinc blocks, one of them polished, were placed below the photographic plate upon which the latter rested. On this were a strip of copper, one of lead, a triangular and thicker piece of uranium, and a piece of metallic indium about one millimeter thick and three centimeters square. Fifteen centimeters above this combination the discharge tube was operated for twenty-five minutes, the rays being directed downward. The zinc blocks were below the lateral edges of the plate and covered each about a third of its area. There certainly is nothing ambiguous about the result, and the degree of polish seems to have nothing to do with the effect. The middle third is distinctly darker than the rest in those parts just under the metal pieces.

The transverse strip in the middle was lead and is distinctly less pervious than the copper on the left.

In looking up some of the early work of Röntgen I found that one of his experiments was almost identical in character with those just described, but less strenuous and designed for quite a different purpose.† He arranged star-shaped pieces of four metals, platinum, lead, zinc, and aluminium, covered by a light-protected photographic plate, film toward the stars and glass toward the tube. On development after exposure to the rays from a focus tube identical in principle with that universally used at present, the metal stars showed darker than the rest of the ground. The purpose of his experiment was to demonstrate a possible reflection from the metal stars, and the result obtained was interpreted as conclusive evidence at the time that such was the case.

For obvious reasons it seemed desirable to repeat Röntgen's experiment as nearly as possible as he made it. This was done with some difficulty, on account of the fact that the apparatus in use developed rays of such penetrating power that the glass backing of the sensitive film offered little obstruction, and even with a very short exposure the whole film was so dense as to show nothing of the metal pieces.

Increasing the thickness of the glass made it possible, after several trials and by using a contrast-developer especially prepared for overexposures, to produce a fairly definite result. The parts of the film just next the pieces are *less* dense than the rest—i. e., the shadows are light on a darker ground.

The accompanying figure shows the result when to the glass of ordinary thickness was added thick blocks of zinc. The characteristics of these two plates are identical, except that the latter is more dense and shows greater contrast.

Another plate was made just as was that of the figure, except that the exposure was thirty minutes instead of fifteen. The appearance is certainly remarkable, for though the direct X-rays had been entirely cut off by the zinc blocks the shadows are exactly as would have been produced by reversing the process and exposing directly to the Röntgen rays, though for a much briefer time.

The influence on the side of the plate remote from the tube seems to have more than neutralized the Röntgen reflection effect, and the more so the greater the exposure.

From these three experiments it seems probable that with a much less powerful X-ray generator, a suitable exposure would show the result noted by Röntgen. As is seen below, this was probably not due to reflection.

As an interesting modification of this experiment I asked one of my associates, Dr. Richards, to hold his hand beneath the plate, protected above with thick metal blocks, and exposed the combination five minutes. The result, though lacking in definition, is quite like the first radiographs made without a focus tube.

We seem now to be led up to a satisfactory explanation of what we have observed so far—i. e., of this apparent "nether effect" reaching completely around into the shadow of an obstruction totally impervious to X-rays proper, and acting in a direction just opposite to that of the rays from the tube.

It must be noted here that so-called "X-ray diffusion" has long been recognized, and an early experiment* with a fluoroscope behind a thick steel plate was explained variously, the most thoughtful suggestion perhaps being by Prof. Elihu Thomson, who proposed that the screen was rendered luminous by the action of X-rays reflected from various objects in the room.

From all the experiments yet made in the effort to account for what at first seemed to be, to say the least, a paradox of science, it looks as if the whole space field in the neighborhood of a focus Crookes tube in operation is full of some sort of subtle energy, radiant possibly, but incapable of affecting the human eye, though leaving its mark on a photographic plate.

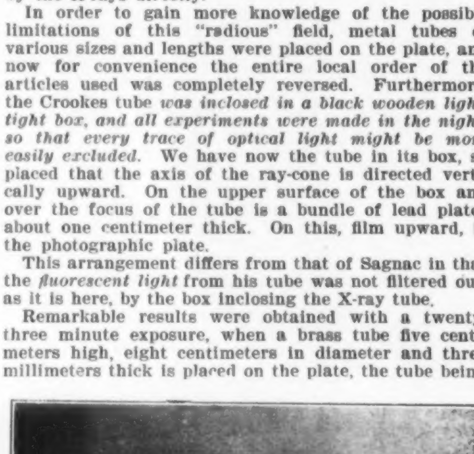
It was found by Sagnac† that many bodies in the path of X-rays acquire the property of emitting emanations of some sort capable of causing fluorescence and photographic action.

Undoubtedly then the effects above described are due to the secondary radio-activity of the air, the table and other bodies favorably located to be impinged by the X-rays directly.

In order to gain more knowledge of the possible limitations of this "radious" field, metal tubes of various sizes and lengths were placed on the plate, and now for convenience the entire local order of the articles used was completely reversed. Furthermore, the Crookes tube *was inclosed in a black wooden light-tight box, and all experiments were made in the night, so that every trace of optical light might be more easily excluded.* We have now the tube in its box, so placed that the axis of the ray-cone is directed vertically upward. On the upper surface of the box and over the focus of the tube is a bundle of lead plates about one centimeter thick. On this, film upward, is the photographic plate.

This arrangement differs from that of Sagnac in that the *fluorescent light* from his tube was not filtered out, as it is here, by the box inclosing the X-ray tube.

Remarkable results were obtained with a twenty-three minute exposure, when a brass tube five centimeters high, eight centimeters in diameter and three millimeters thick is placed on the plate, the tube being open at the top. The experiment was repeated with a thick block of pine wood, placed on top of the brass tube, with no change in result. The condition of the inclosed space is independent of the presence of the wood, and the inclosed area of the film is much affected.



RADIOGRAPH OF VARIOUS OBJECTS.

When, however, the tube is covered with a thick block of zinc, this seems to protect the sensitive film completely from outside influence, for the density of the exposure was found to be the same over the area within as under the edge of the tube, i. e., nearly zero.

It does not seem possible that this effect could result entirely from the action of the Sagnac rays, since little if any of the area at the base of the brass cylinders can be reached by a straight line from any particle of matter traversed by the direct X-rays. It can be explained as a tertiary effect, produced by the air or wood just over the top, which had received its energy from the secondary emanations of other bodies in the direct path of the X-rays, or possibly the secondary or Sagnac rays may be of the nature of dark phosphorescence, i. e., lasting for a time after the cause has ceased. Reasons for favoring the latter view appear as a conclusion to this paper. If this case the diffusion of the air in the room would cause the whole space to be uniformly active.

The arrangement just described suggested some easy tests on reflecting or diffusing power of different surfaces, as Sagnac had made in a different way in his investigations. In a brass tube similar to the one used above, at two points 90 deg. apart, windows were cut 1 centimeter wide and 4.5 centimeters high. This tube was capped with zinc or lead, so that nothing could enter except through the windows. It was placed on the plate and a polished zinc block arranged opposite one window. The exposure was twenty minutes. The streak entering the window opposite the zinc is unmistakable, and the diffused "radious" state of the whole inclosed space is demonstrated by noting the line of contact of the tube. A little brush in at the other window, too, is clearly distinguishable though faint. It seemed most desirable now, if possible, to make this phenomenon optically visible, and with this in view the following arrangement was set up:

Instead of the smaller lead block used with the radiographic plates, sheets aggregating one centimeter in thickness and a little larger than a 7 x 9 screen were placed on the box. On this a barium platinum cyanide screen was placed, face up, but covered with a piece of pasteboard. In this cover a circular hole was cut just the outside diameter of the window tube described above, through which the latter was placed, resting on the fluorescent screen. Its length was doubled by placing an extension on top. This was found by experiment effectually to exclude all noticeable influence except that through the windows.

The whole was in a perfectly dark room optically and the eye was placed above the tube looking down. After the eyes had acquired a maximum sensitiveness by the total exclusion of light for ten to fifteen minutes, the Crookes bulb was set in operation and the space within the brass tube critically examined from above. The screen was unmistakably luminous to the eye and the windows were clearly located. Now the polished zinc was moved about in front of one of the openings, in the hope of detecting a variation of luminosity on the screen opposite this window. The result was at first disappointing; the position of maximum effect was certainly not that of 45 deg., as employed in the photographic experiments. In fact, very inconsistent positions seemed to give the greater illumination through the window under attention. Finally it became quite obvious that the zinc had little to do with what was visible. In fact, on laying aside the metal I was able to light up brighter than ever the inside of the brass box by holding my hand in a suitable position in front of the window.

This experiment made certain by ocular demonstration that the human hand has by being placed in the path of the X-rays absorbed some sort of energy, by means of which it has acquired the property of emanating something capable of exciting fluorescence upon the screen. It remained now to demonstrate what effect these emanations had upon a photographic plate as compared with those from the zinc. A three-minute exposure with my hand only, placed opposite one of the windows, the tube resting upon a photographic plate in its usual protecting envelopes, gave good results. A similar experiment was next tried by holding a hand in front of each window, one of the latter being closed by a thin sheet of plate glass. It is obvious from the results obtained that the physiological rays emitted by the hands affect the plate through its protecting covers, but are unable easily to penetrate glass.

It was only a step now to produce a "physio-radiogram." A record was made by the secondary activity emanating from my own hand stimulated by a stream of Röntgen rays with an exposure of three minutes. The shadows obtained were those of a cent, a gold finger-ring, and a piece of aluminium about half a millimeter thick, and it was apparent that aluminium is somewhat translucent to these rays.

Although Guilloz* had made just such shadow radiographs with Sagnac rays emanating from his hand, the visible fluorescence generated by the tube was not cut off by any opaque screen, and there is no reason for assuming that this light may not have played some part in his results. In the present experiments everything has been done in complete optical darkness.

I have been unable to find out if Guilloz's pictures were actually published, and so cannot compare his results in detail with my own.

In connection with the present subject, my attention has been called by unpleasant personal experience to a very suggestive coincidence. The nature and pathology of X-ray dermatitis is, and has been from the first, surrounded with mystery. Much ingenious technical literature has been published in the medical journals all over the world for the last six years, with the result that to-day little is known about either the real cause, the nature, the proper method of preventing, or the best treatment of this most distressing and lingering affliction. A comparative history of many cases reveals many inconsistencies, followed by an increased sense of ignorance on the subject. The personal experience to which I refer suggests a possible step toward a better understanding of the phenomenon.

During a week in June, 1902, I occupied the Röntgen ray room as a sleeping apartment. At the end of this time an acute inflammation of the eyes and throat appeared, all symptoms of an ordinary cold or of any digestive disturbance being absent. At the end of the week referred to I left town and the inflammation gradually subsided during the next three or four days. For similar reasons I had occasion to sleep in the same room during the first week of the present month. At the end of that time my attention was painfully called to a recurrence of the symptoms observed a year ago. On ceasing to sleep in the room all trouble disappeared.

As I have never had any such experiences other than those refered to, it seems not too much to infer that the peculiar inflammatory condition may have been due to some action of the secondary emanations sent out by the walls and air of the room after the generation of X-rays had ceased. Continuous breathing of such "darkly phosphorescing" air might well account for the trouble in the throat and vocal chords. In the daytime the doors and windows were always more or less open, so that the air was continuously changing, and my eyes were protected considerably by glasses, through which neither the primary nor the secondary rays pass easily.

The inference seems fair that the recurrence of the inflammatory condition was not a mere coincidence, and that these secondary rays may be found to be of more importance than has been supposed.

EXPERIMENTS ON CHEMICAL AFFINITY AT LOW TEMPERATURES AS DETERMINED BY THE REACTION OF LIQUID FLUORINE.

By Profs. HENRI MOISSAN and JAMES DEWAR.

A NUMBER of experiments of great interest have lately been carried out by Profs. Moissan and James Dewar upon the properties of liquid fluorine at extremely low temperatures. As fluorine is one of the most active bodies known, the experiments serve to demonstrate what becomes of chemical affinity at such low temperatures. This work was difficult to carry out for two reasons, first, that a body cooled to —100 or —150 deg. C. attracts the moisture of the air with great energy and is almost at once surrounded with a layer

* Reprinted from Proceedings American Philosophical Society, vol. xlii, No. 173.

† Thompson, X-Rays, p. 70.

* Thompson, X-Rays, p. 120.

† Sagnac, Comptes Rendus, 1897-98. Sagnac, Annales de Chemie et de Physique (7), xxii, 1901; pp. 493-563. Perrin, Comptes Rendus, vol. cxxiv, p. 455. Townsend, J. S., Proc. Camb. Philos. Soc., 1900, x, pp. 217-226.

* Guilloz, Compte Rendus, February, 1900.

of ice which is solid and often transparent, and this suffices to prevent all reactions; second, the superficial combination which is sometimes produced also limits the reaction. This second effect, which is produced for instance when sodium is acted upon, is all the more important, as we know scarcely anything about the solubility of simple or compound bodies in liquefied gases. In order to prove that chemical affinity still holds good at very low temperatures, the authors undertake the study of fluorine on different bodies by substituting liquid fluorine for the gaseous form.

To realize these experiments the body to be studied was placed in a glass tube of small diameter, carefully dried. This tube, 6 or 8 inches long, was sealed up at the ordinary temperature to avoid the absorption of moisture; it was then placed in liquid air at —190 deg. C. On the other hand, the fluorine was liquefied in a tube whose diameter was much greater than that of the tubes containing the samples. At the moment of making the experiment, the end of the sample-tube was cut off and it was inverted quickly into the liquid fluorine. By lifting it up, the body to be observed is allowed to fall into the liquid. A great variety of simple and compound bodies were studied in this way, and many of them gave very interesting reactions at this low temperature. Iodine, however, which takes fire in fluorine gas and forms a pentafluoride of iodine, has no reaction in liquid fluorine. Pure liquefied oxygen has also no reaction on liquid fluorine at —187 deg. C. On allowing the temperature to rise, each of the two simple bodies separates at its boiling point. When a piece of dry sulphur is let fall in liquid fluorine an intense flame of a livid blue color is immediately produced, which soon fills the whole apparatus. The glass tube is broken on account of the heat, and when the excess of fluorine is volatilized, the glass is seen to be covered with a crystalline layer of hexafluoride of sulphur, which soon takes the gaseous form. With selenium the reaction is still more violent at —187 deg. When the selenium comes in contact with the fluorine a flame is produced, accompanied by a detonation which is strong enough to break the tubes and the double-walled vessel filled with liquid air within which the experiments are made. After the explosion the glass is found to be covered with a layer of red selenium. When red phosphorus, quite dry, is let fall in the liquid, it combines at once and forms a flame, giving pentafluoride of phosphorus, which is rapidly solidified and afterward takes the gaseous state when all the fluorine is volatilized by reheating the tube. Arsenic also acts with great violence, and a fine blue flame is produced; after the fluorine is volatilized there remains a solid fluoride of arsenic. Nitrogen has no reaction either at the ordinary temperatures or when both gases are liquefied. Antimony falls to the bottom of the liquid fluorine and is not attacked, still preserving its brilliant appearance.

The different varieties of carbon, also crystallized silicon and amorphous boron, have no action upon liquid fluorine at its boiling point. When a small fragment of wood charcoal or a flake of lampblack is let fall into the tube containing the liquid fluorine, the carbon becomes incandescent when it traverses the gas but is put out on reaching the liquid. Sodium when in contact with the liquid remains brilliant but is covered with a thin transparent layer of fluoride of sodium. Potassium does not react at first, but after 20 seconds or more a combination is produced with a violent explosion which shatters the tube. Some of the reactions given by composite bodies are very energetic at low temperatures; thus if a few fragments of dry iodide of potassium are let fall in liquid fluorine which is kept at a few degrees below its boiling point, no reaction is produced, but when the temperature is raised to the boiling point there is a rapid decomposition. The iodine is displaced from its compound and owing to the elevation of temperature it burns in the fluorine. Iodide of mercury does not react in liquid fluorine, but takes a yellow tint owing to the extreme cooling. Silicon and boric anhydride fall to the bottom and show no effect, but on the contrary lime is violently attacked. It is raised to incandescence and the tube is broken from the intensity of the reaction. Carbide of calcium gives no effect. Among the organic bodies, anthracene when crystallized and quite dry, placed in contact with liquid fluorine at —187 deg. C., gives a violent reaction with disengagement of heat, explosion and deposit of carbon. Iodoform, however, shows no effect, nor sugar, morphine, etc.

These experiments show, therefore, that the affinity of fluorine at a temperature of —187 deg. C. is still strong enough to ignite sulphur, selenium, phosphorus and arsenic, and to give a violent reaction with incandescence in the case of oxide of calcium, also to form an explosive mixture with anthracene. It is thus demonstrated that chemical affinity still holds good at these low temperatures, when energetic reactions are employed such as those of fluorine with simple or compound bodies.

THE DEATH OF DR. J. V. LABORDE.

DR. JEAN BAPTISTE VINCENT LABORDE, died recently at the age of seventy-two. He was born at Buzet (Lot et Garonne), and received a good education at the Lycée of Cahors, after spending some time in a boarding-school at Casteljaloux. He went to Paris, without any resources, to study medicine. He obtained the gold medal of the hospitals, the Corvisart prize, and another prize from the Société Médicale des Hospitaux, and lastly, in the very year in which he got his doctor's degree, the Godard prize, awarded by the Société Anatomique de Paris.

In 1872 Laborde gave up pure medicine to devote himself to scientific works, particularly to physiology. He studied the acid of the gastric juice, trying to show that it never existed uncombined (1874-77), the rhythmical function of the heart and its development in the embryo (1876), and more especially the function of the central nervous system, and of the bulb in particular (1877-1880). He clearly explained the two possible causes of death, either a stop of the respiratory movements with persistence of the beating of the heart or *vice versa*. He showed also the functional association of the eyes in the binocular vision, owing to the narrow connections between their motor nerves.

His special study was experimental physiology applied to therapeutics and toxicology; he published works on the properties of many substances, such as the narceine (1866), which he considered as the best sedative of the nervous system; the bromides, the soothing influence of which he investigated (1867-1869), the eserine or alkaloid of the Calabar bean (1869); propylamine (1873); aconitine, the advantages of which he showed as a sedative of sensibility (1875); colchicine, sparteine, boldo, salts of strontium, etc.; lastly, in 1877, he published a study on the alkaloids of cinchona, which he named in the following order, according to their poisonous qualities: Cinchonine, cinchonidine, quinidine. In fact, he made a special study of poisons in general, animal as well as mineral, natural as well as artificial.

In concluding this cursory view of Laborde's works, we cannot do better than mention his ingenious method of the rhythmical tractions of the tongue, which was sufficient to make the name of its inventor known throughout all the world. There is no need to expatiate on his most simple and efficient process of setting the respiratory reflex to work. It is known and used everywhere, and it has called back to life numbers of apparently drowned or suffocated people.

CENTENNIAL CELEBRATION OF THE BIRTHDAY OF JUSTUS VON LIEBIG.

By DURAND WOODMAN.

BY invitation of the Verein Deutscher Chemiker, New York Section, the members of the American Chemical Society, the Society of Chemical Industry, the Electro-Chemical Society and the Chemists' Club, participated, recently, in a celebration in memory of the illustrious investigator and chemist, Justus von Liebig, who was born on May 12, 1803.

The societies met in the Assembly Hall of the Chemists' Club and listened to addresses by Dr. Ira Remsen, president of Johns Hopkins University; Prof. William H. Brewer, of Yale; Dr. Carl Duisberg, vice-president of the Verein Deutscher Chemiker and managing director of the Farbenfabriken, of Elberfeld, Germany.

The exercises were opened by Dr. H. Schweitzer, chairman, who welcomed the assembly and foreign guests, and introduced the speakers.

Dr. Remsen outlined the early life of Liebig, mentioning his unpromising inaptitude for study at school, which resulted in giving it up and devoting himself to chemistry; his first interest in which was aroused by the study of colors and dyestuffs. Later, while at a country fair, he saw an exhibition of Pharaoh's serpents, accompanied by some chemical operation connected with their preparation which led eventually to his study and investigation, while attending the lectures of Gay Lussac at Paris, of the cyanides, cyanates and fulminates. This work resulted in his introduction to Gay Lussac, who admitted him to his private laboratory. He was appointed a professor at the University of Giessen, in his twenty-first year, 1824, where his laboratory was of the crudest character, not much better than a barn without flooring; but from this modest beginning, with only six or seven students, his work grew and his reputation spread; a new laboratory was built and students came to it from all quarters.

During the twenty-eight years at Giessen the activity of Liebig and the work he accomplished were enormous, and he can be truly considered the greatest chemist of that time. His publications in scientific journals amounted to more than two hundred papers, in addition to his works on agriculture, organic chemistry and analysis; besides acting as editor of several scientific journals.

Coming to personal reminiscences of the time when he attended the lectures of Liebig at Munich, Dr. Remsen described the difficulty he experienced as a student in attempting to harmonize the old system as taught by Liebig, with the new as taught by his assistant, Volhard. Speaking of his methods he said that all Liebig's lectures were profusely illustrated by experiments, many of them so elaborate as to be unthought of in the present day lecture room—metallurgical experiments requiring wind furnace, and many others which the speaker said he would now hardly believe could have been done on the lecture table if he had not preserved his note book filled with rude drawings of all the apparatus used.

Liebig was fond of a little dramatic effect, and took some care to bring his lectures to a climax with the most effective experiment, whether with a big flash of flame or an explosion or otherwise; and while the present method is more severe and straight laced, the speaker said he was not certain that the impressions made and the train of thought aroused by Liebig's method were not very effective.

It was extremely difficult to get admission to Liebig's laboratory as a student; in fact, it was one of his conditions on accepting the professorship at Munich, that he should not give his time or attention to students. In appearance, Liebig was large of stature and of fine bearing; one of nature's noblemen, but very emphatic in berating his assistants when the experiments went wrong, his language on such occasions being more remarkable for condensed energy than for rhetorical elegance.

Prof. Brewer, who is the oldest living pupil of Liebig in this country, and who has been his devoted follower in the line of agricultural chemistry, told of his enthusiastic desire to study under him, aroused by reading a translation of his work on agriculture in 1846. A few years later he went abroad, and with letters of introduction went to Munich. Here he found Ogden Rood, afterward professor of physics at Columbia University, who offered at once to introduce him to Liebig, and assist in every way toward the desired end. But Rood advised him not to use his letters of introduction; not to call Liebig "Professor," but "Herr Baron," to have plenty of assurance, and not to spare flattery. With this preparation, the introduction was brought about and Brewer stated his mission. Liebig assured him that he would do better to go somewhere else. He said: "I will give you no attention; no attention." This assurance met every advance until finally the speaker said: "I told him I had come three thousand miles to sit at the feet of the greatest teacher of chemistry in Europe and I am going to remain here." "Well," said Liebig, "see Mr. Meyer."

He saw "Mr. Meyer" and a place was set apart in the laboratory for the new student, who remained there a year, but actually received practically "no attention," except when he showed some organic crystals to him which had the appearance of potassium nitrate, and were so pronounced by Liebig on sight. The effort to convince him that they were organic was followed by a sound berating for "contradicting," which was later followed by demonstrating to the great professor that no contradiction had been intended, and that the crystals were in fact "very peculiar." Prof. Brewer's address was full of personal interest, and was followed with the closest attention.

Dr. Carl Duisberg read a paper describing the influence of Liebig on chemical industry, his teachings resulting in that knowledge of the importance of scientific method which has so largely displaced the "rule of thumb" man by trained chemists in all the great chemical industries of Germany, and more or less in other countries. Liebig's influence was exerted chiefly on the organic chemical industries, and much of their progress is due to his activity and energy while at Giessen.

"A staff of his pupils making their way to all quarters of the globe disseminated his ideas in assisting agriculture and the chemical industries, and as the first systematic teacher of laboratory methods, the credit is justly due him for an influence which can hardly be measured or described."

THE CANALS OF MARS.

By EDMUND LEDGER.

IF it be proposed to admit the actual objective existence upon Mars of these very numerous formations, many difficulties immediately arise. All who have seen them have been puzzled by their number; the complexity of their interlacing and triangulation; their visibility when the disk of the planet is of very small size; their straightness; their immense length, which in some cases reaches to 3,000 to 4,000 miles (nearly equal to a whole diameter of the planet); and their uniform and great breadth, in different instances estimated at 30, 40, or even 60 miles. This breadth has naturally suggested that it must at any rate be a mistake to imagine them to be lines of water, but that it is more likely that they may be lines of vegetation extending along a canal of water which is itself too narrow to be seen. It is to be noted that the very narrowest line which it is considered that a telescope can possibly reveal upon Mars must be at least 18 miles in width. As to the distance between the two lines of the doubled canals, the observations indicate that it varies from about 30 to as much as 360 miles.

The visibility of the canals is observed to be greater some times than at others. Now, it is probable that the climate of Mars is very dry, its atmosphere of small density, its clouds rare, and its land mainly desert. Nevertheless, white spots are seen around its poles, which are generally termed the polar snows. These wax and wane with the alternation of the summer and winter of the two hemispheres, and are most likely not of great thickness, as they almost, and sometimes altogether, disappear in the height of the summer. Mr. Lowell has consequently strongly maintained that the melting of such a polar snowcap forms a sea of water around its boundary, from which a supply gradually finds its way into the canal system, causing vegetation to spring up, as on the earth along the Egyptian Nile. The circular spots observed at the intersection of two or more canals might, in that case, be fertile oases in the midst of surrounding desert.

As numerous almost as the writers who have discussed the canals are the varied hypotheses promulgated for their explanation. Some have suggested that they may be tracks drawn by meteorites as they have rushed along the surface; or by minor planets, which became close satellites of Mars in the earlier stages of its formation, and presently in grazing contact ran round and round it. Others have supposed that they may be fissures, generally following the course of great circles, and in some parts radiating from central points. These, it is said, might be caused by the cracking of an unsupported crust left behind by a contracting interior; or, on the other hand, by the resistance of the interior to the contraction of a more rapidly cooling crust. It has even been suggested that vapors continuously rising out of such fissures may perform a part in producing the single, or doubled, appearance of the various canals. The space at my disposal forbids the mention of other theories, or the discussion of such as I have named. They are all, I believe, unsatisfactory. They all alike involve great improbabilities, and fail to satisfy the necessary conditions.

The general appearance, as well as the exceedingly complicated interlacing and arrangement of these numerous so-called canals, is therefore of so puzzling and enigmatical a character that I think it may well suggest the question: Are they really there?

It is, I think, probable, that the so-called canals (with the exception perhaps of a few of the darkest and most prominent seen with low telescopic power) may not really exist upon Mars; and also that the apparent doubling, seen in many of them, may be still more delusive. I think that what is seen may for the most part be an appearance produced by the observer's eye, when affected by the strain of long and earnest gazing through the telescope. I consider that this conclusion is supported by experiments, and by the physiology of accommodation, astigmatism, and diplopia in the human eye. And I believe that there is also a subtle influence which is often conjointly effective upon the brain and nerves of an observer.

When much has been seen, more is wished for, and the more *is* seen. Those who once begin to see canals generally go on to see an increasing number; and others may presently see what they have recorded. Even Antoniadi wrote, in 1898, that "had it not been for Prof. Schiaparelli's wonderful discoveries, and the foreknowledge that the canals are there, he would have missed at least three-fourths of those seen now."

Many of the drawings of portions of the surface by

Schiaparelli, which have been very often reproduced, easily impress themselves on the memory. They may, therefore, be the more likely to form imaginary cerebral images. It is certain that individual observers have occasionally drawn some features as they had previously been depicted in Schiaparelli's charts, when many other observers have testified that they could not be seen at that particular time.—Nineteenth Century.

THE RAPID ANALYSIS OF WATER.

THE potability of water constitutes at present one of the most important questions of hygiene, since the use of this liquid as an exclusive drink is becoming more and more widespread in all classes of society, either by preference or as a medical necessity. Such use of water presents numerous advantages, but may, nevertheless, sometimes offer serious inconveniences. We know, in fact, that a number of diseases of the most dangerous character owe their origin to water. Aside from cholera, typhoid fever, and dysentery, there are a number of gastric or intestinal troubles that have no other cause. There is, then, a genuine and serious danger in the use of water in the hard state as a drink, when we are not certain of its purity. The public authorities well understand the importance of this question, and, in order to supply a city with wholesome water, take thousands of precautions, which, however, often prove inadequate, since accidental contaminations are continually to be apprehended. The danger is still greater in the rural districts, where the water is submitted to no surveillance, and where the causes of accidental contamination are often more frequent. It is therefore almost absolutely necessary for the inhabitants of a city or the country, as well as for travelers, explorers, and simple tourists, to be able easily to ascertain the quality of the water that they are obliged to drink. There are certain signs characteristic of the contamination of water, but these can be put in evidence only by chemical or bacteriological analyses, both of which constitute lengthy, delicate, and troublesome operations that can be performed only in a laboratory and by experienced hands.

To simplify bacteriological analysis is impossible; but we can always rely upon chemical analysis as being quite sufficient. In fact, as Prof. Chantemesse says, "although bacteriological analysis plays an important part in the diagnosis of the qualities of a potable water, it does not play an exclusive one," since the chemical composition of the liquid has a very great influence upon the existence, nature, and virulence of microbes. Moreover, bacteriological analysis has not always given decisive results, and M. Duclaux, manager of the Pasteur Institute, on the one hand, and M. A. Gautier, on the other, have shown by researches made in different countries in which epidemics of typhoid fever and dysentery had prevailed that a chemical analysis, even a summary one, would have sufficed to reveal the suspicious character of certain waters.

We have, therefore, say MM. Pignet and Hue, in La Nature, finally given preference to this form of analysis, and, taking as a basis a pharmaceutical preparation called "compressed tablets," have succeeded in creating a simple, quick, and practical process of analysis that permits of the examination of water by anybody, under all circumstances, and without any special knowledge. These tablets, which are accurately proportioned and may be preserved indefinitely, replace the titrated liquids and solutions and complicated apparatus in ordinary use.

For a complete analysis, nine tablets and two small bottles of liquid reagents are all that is necessary. The apparatus, which is very simple, consists of a few test tubes, test glasses, etc., the whole contained in an easily transportable box 35 centimeters in length, 20 in width and 15 in height. The operations are seven in number: quantitative analysis (1) of the nitrites, (2) of the nitrates, (3) of the free and albuminoid ammonia, (4) of the chlorides, (5) of the organic matters, (6) determination of the hydrometric degree, and (7) examination for iron, copper, zinc, etc.

In order to give an idea of the simplicity of the process we cannot do better than give a brief description of the method employed in some of our researches.

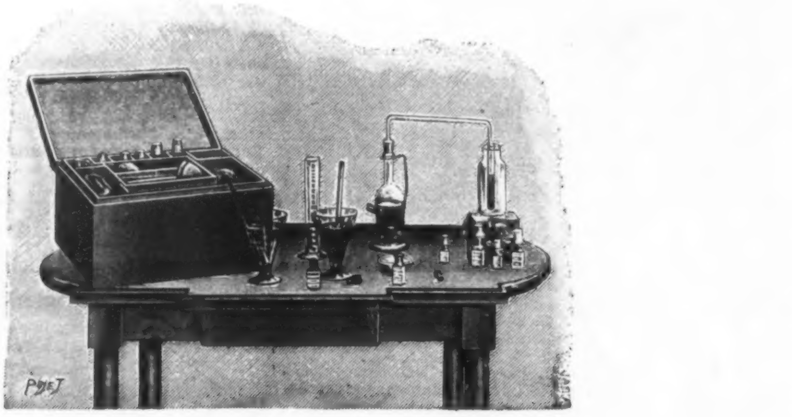
Example I.—Determination of the presence and proportion of the nitrites and nitrates. Dissolve an iodide tablet in 100 cubic centimeters of water contained in a test glass and afterward add to it an acid tablet. After the two tablets are dissolved, one of two cases may present itself: either the liquid will remain colorless, even after five minutes have elapsed, or else a blue color will develop more or less rapidly during the same space of time. In the first case, the absence and in the second the presence of nitrites is revealed. The rapid appearance of the blue color and its intensity indicate, upon reference to rules established by us, the proportion of the nitrites contained in the water.

If, in operating under the above conditions, it is found that the water remains colorless, add a zinc tablet in order to test for nitrates. As before, one of two cases may present itself: either the water will remain colorless, even after five minutes have elapsed, or else it will take on a blue color. Here again the rapidity and intensity of the coloration serve to show the proportion of the salt contained in the water.

From the view point of the contamination of water, the test that we have just described is of prime importance, since potable water should not contain nitrites, which are a sign of the presence of organic matters in process of a transformation caused by microbes. The nitrates, without having the same importance, nevertheless indicate a certain degree of pollution, when the quantity thereof exceeds a determinate limit. With the process under consideration, it is possible to effect these two analyses in ten minutes and to ascertain the quality of the water in the dining room of a modern hotel as well as at the source of supply of a village tavern.

Example II.—Determination of the presence of chlorides. Put a chromium tablet into 100 cubic centimeters of water, and the latter will assume a yellow color. Then add tablets of nitrate of silver successively until the liquid becomes red. Since each tablet corresponds to 10 milligrammes of chromium, the water contains as many times 10 milligrammes of chromium per liter as the number of tablets added.

Example III.—Determination of the hydrometric degree, that is to say, the richness of the water in calcareous or magnesian salts. Put 40 cubic centimeters of water into a 100 gramme bottle, dissolve therein a soap tablet and shake well. If no persistent lather is produced, add tablets until it is. Each tablet corresponds to 4 hydrometric degrees. These two operations are very important from an industrial standpoint. No one, in fact, is ignorant of the rôle of the chemical composition of water in its industrial applications. The engineer and manufacturer will find in this process an easy and quick method of ascertaining the quality of the water that they employ.



APPARATUS FOR THE QUICK ANALYSIS OF WATER.

THE GREAT MANUFACTURING STATES.

IT is a somewhat curious fact, says the Chicago Tribune, that the seven States which stood first in 1890 in the value of manufactured products stand first again in 1900, and in exactly the same order: First of all comes New York; second, Pennsylvania; third, Illinois; fourth, Massachusetts; fifth, Ohio; sixth, New Jersey, and seventh, Missouri. Illinois is third in population, as in manufactured product. In that respect it occupies a normal position. Its output per unit of population is $261, compared with New York's $299, Pennsylvania's $291, and New Jersey's $324. The output per unit is affected by the character of the business carried on. New Jersey is the home of the silk manufacturing industry of the United States. It is partly owing to the manufacture of this expensive product that New Jersey, in one respect, outranks Illinois.

RUSSIAN BANKING METHODS IN CHINA.

THE Novoe Vremya gives a by no means flattering account of the methods pursued by the Russo-Chinese Bank in the Far East. It appears that there are ten different nationalities represented among the sixteen employes in the bank there, and there is only one Russian on the staff. The official organ complains that the "directors" of the bank look far more like schoolboys than serious business men, and that neither the practical British merchants, nor the French, nor even the Russians care to avail themselves of the facilities afforded by the bank.

The following is an instance of the bank's procedure. The cost of a ticket from Japan or China to St. Petersburg by the German Lloyd Line has to be paid in marks. The traveler asks the Russo-Chinese Bank to change for him the necessary sum out of, say, £100. The bank converts the English pounds into Chinese taels or Japanese yen and charges brokerage; then the taels or yen are converted into German marks, and commission is again charged; then from this result the sum required for the passage money is deducted, and the remainder is converted into taels or dollars, commission being charged for the third time, and, finally, the fourth operation consists in converting the taels or dollars into English pounds, commission being charged for the fourth time.—The London Globe.

TRADE NOTES AND RECIPES.

Gold Printing on Oilcloth and Imitation Leather.—Oilcloth can very easily be gilt if the right degree of heat is observed. After the engraving has been put in the press, the latter is heated slightly, so that it is still possible to lay the palm of the hand on the heated brass plate without burning it, or better, without even any unpleasant sensation. Go over the oilcloth with a rag in which a drop of olive oil has been rubbed up, by which treatment it acquires a thin, greasy film. No priming with white of egg or any other priming agent should be done, since the gold leaf would stick. By sprinkling on gilding powder, a lustrous gilding cannot be obtained. The gold leaf is applied direct on the oilcloth, which has been slightly oiled; then shove into the lukewarm press, squeezing it down with a quick jerky motion and opening it at once. If the warm plate remains too long on the oilcloth, the surface covering of the latter will soften under the radiating heat and the gold leaf will stick. When the impression is done, the gold leaf is not swept off at once, but the oilcloth is first allowed to cool completely for several minutes, since there is a possibility that it has become slightly softened, especially at the borders of the pressed figures, under the influence of the heat, and the gold would stick there if swept off immediately. When the work is manipulated as per directions, the printing must be sharp and neat and the gold be glossy. The whole operation, besides, is so simple that it requires less time than the popular bronze printing so much in use upon oilcloth. For the latter a preliminary treatment of printing with varnish ground has to be given, and the bronze is dusted on this varnish. Naturally this is not so durable as gold printing, nor does it look as pretty and neat, since it lacks the luster which distinguishes gold-leaf printing.

The leather paper (imitation leather) now so much in vogue is generally treated in the same manner. The tough paper substance is made to imitate leather perfectly as regards color and pressing, especially the various sorts of calf, but the treatment in press gilding differs entirely from that of genuine leather. The stuff does not possess the porous, spongy nature of leather, but on the contrary is very hard, and in the course of manufacture in stained-paper factories is given an almost waterproof coating of color and varnish. Hence the applied ground of white of egg penetrates but slightly into this substance, and a thin layer of white of egg remains on the surface. The consequence is that in gilding the leaf gold is prone to become attached, the ground of albumen being quickly dissolved under the action of the heat and put in a soft sticky state even in places where there is no engraving. In order to avoid this the ground is either printed only lukewarm, or this imitation leather is not primed at all, but the gold is applied immediately upon going over the surface with the oily rag. Print with a rather hot press, with about the same amount of heat as is employed for printing shagreen and title paper. A quick jerky printing, avoiding a long pressure of the plate, is also necessary in this case.—Der Stein der Weisen.

Silvering Glass Globes.—Workshop Receipts, an English formulary, is authority for the following:

(1) Take 1-3 ounce of clean lead, and melt it with an equal weight of pure tin; then immediately add ½ ounce of bismuth, and carefully skim off the dross; remove the alloy from the fire, and before it grows cold add five ounces of mercury, and stir the whole well together; then put the fluid amalgam into a clean glass, and it is fit for use. When this amalgam is used for silvering, let it be first strained through a linen rag; then gently pour some ounces thereof into the globe intended to be silvered; the alloy should be poured into the globe by means of a paper or glass funnel reaching almost to the bottom of the globe, to prevent it splashing the sides; the globe should be turned every way very slowly, to fasten the silvering.

(2) Make an alloy of 3 ounces of lead, 2 ounces of tin and 5 ounces of bismuth; put a portion of this alloy into the globe, and expose it to a gentle heat until the compound is melted; it melts at 197 degrees F.; then by turning the globe slowly round an equal coating may be laid on, which, when cold, hardens and firmly adheres. This is one of the cheapest and most durable methods of silvering glass globes internally.

(3) Nitrate of silver, 1 ounce; distilled water, 1 pint; strong liquid ammonia, sufficient quantity, added very gradually, to first precipitate and then redissolve the silver; then add honey, ¼ ounce. Put sufficient quantity of this solution in the globe, and then place the globe in a saucepan of water; boil it for 10 to 30 minutes, occasionally removing it to see the effect.

Manufacture of Aluminium Bronzes.—According to a French authority an alloy of the following composition gives the best results:

Copper, 89 to 98 per cent, aluminium and nickel, 1 to 2 per cent. Aluminium and nickel change in the opposite way, that is to say, in increasing the percentage of nickel the amount of aluminium is decreased by the equal quantity. It should be borne in mind that the best ratio is aluminium, 9.5 per cent, nickel, 1 to 1.5 per cent at most.

In preparing the alloy a deoxidizing agent is added, viz., phosphorus to 0.5 per cent, magnesium to 1.5 per cent. The phosphorus should always be added in the form of phosphorus-copper or phosphor-aluminium of exactly determined percentage. It is first added to the copper, then the aluminium and the nickel and finally the magnesium, the last named at the moment of liquidity, are admixed.—Neueste Erfindungen und Erfahrungen.

Composition for Cleaning Painted or Varnished Surfaces.—The specifications of a recent English patent call for lemons, or other acid fruit, 2 pounds, hydrochloric acid, 1 pound, and water, 4 pounds. These are mixed, boiled to a thick paste and incorporated with oxalic acid, 2 pounds, and black treacle, 3 pounds. When cold, butyric acid, 1 fl. ounce, or other grease-dissolving acid is stirred in, and the whole made up to 1 gallon with water. The composition is applied to the painted, varnished, or polished surface, left for a sufficient time, and then washed off.—Pharm. Era.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Timber Concessions in Dutch Guiana.—Minister Newel transmits from The Hague, under date of May 15, 1903, a statement from the governor of Surinam relating to concessions for cutting timber in Dutch Guiana, which reads, in substance:

"No concession of less than 400 hectares (988.4 acres) is granted. Thus far, the concessions are granted only for squares or rectangular plots, with payment in advance at the rate of 10 cents per hectare (2.471 acres) and for one year. The holder has a prior right to renewal of the concession. The grants are made by the government of Surinam and the government reserves the right, at all times, of instituting an inquiry into the manner in which the work is carried out. The holder of the concession is empowered to avail himself of all the different sorts of wood found on the territory, with the exception of the bolletrie boom (*Lucuma mammosa Juss*). Pending further regulations by colonial order, these concessions shall be granted on the following conditions:

"1. Except for the cutting down of fuel and the working of timber, no trees shall be felled, deprived of their bark or resin, or injured in any other way, on penalty of $1 for every tree thus injured.

"2. Government right of supervision.

"3. Persons employed shall be under proper control.

"4. Withdrawal of the concession in case of failure to comply with conditions.

"5. Expenses of concession shall be refunded by the holder.

"6. Authorities are not responsible for any differences in the situation, area, form, or boundaries between the territory conceded and the indications of the chart according to which the concession was granted.

"7. The concession does not prevent the erection on the territory of works of public usefulness, either by the authorities or by private persons or societies, with the consent of the authorities, the holder of the concession having no claim to indemnity or subsidy whatever."

Openings for Trade in Asturias, Spain.—Railways.—The Compañia de Ferro-carriles de San Martin, Lieres Gijon-Musel, of Gijon, will receive proposals for the supply of materials for laying lines, and also for the construction of two hydraulic loading tips at the terminus in the port of Musel.

The Sindicato Asturiano del Puerto del Musel, of Gijon, will receive proposals for the construction of electric cranes and of three electric loading tips, the power to be obtained from the works of the Sociedad General de Productos Quimicos de Aboño, now in course of construction about two miles from the harbor.

The Compañia de Ferro-carriles Vasco-Asturiano, of Oviedo, is having a survey made between Lugones and Gijon, in order to construct a line to connect the latter city with the line from Ujo to the port of San Esteban de Pravia.

Electric Tramway.—The Compañia de Tranvias de Gijon is preparing to change its horse traction to electric, and is open to receive offers of electric cars.

Electric Light Station.—The Compañia Popular Ovetense de Gas y Electricidad, of Oviedo, has a project in hand to utilize a waterfall at Cangas de Onis, to generate power for the elec[illegible] light station at Oviedo.—Arthur Lovelace, Acting Consular Agent at Gijon.

Packing of Goods for Foreign Markets.—There is probably no subject which has been more insisted upon by consuls in all parts of the world in their official reports than the proper packing of goods intended for the foreign market. An incident which occurred a few days ago again forcibly brings home the necessity of the most scrupulous attention to the matter of packing goods for the export trade. A shipment of forty cases of machine parts recently arrived at the Chemnitz custom house, intended for a local machine-building concern which ranks as one of the largest in the world. The cases weighed 250 and 500 pounds, in round numbers, there being two sets of goods. They were constructed of heavy two-inch hard wood. With the exception of a number of wrenches, bolts, and the like, the contents of each case consisted of one solid piece. Parts were of delicate construction, consisting of glass plates and glass reflectors set in iron.

Out of a total of forty cases, the contents of but six arrived in good condition. The most serious injuries sustained by the machinery were heavy indentations of the sheet-iron casing, the breaking off of large and important parts of the cast iron frames, and the breaking of glass plates and reflectors.

In one case the iron foundation plate was broken off, due to wrong attachment in the cases and to too spacious packing; in another the electrical conductors were left exposed. It may be mentioned that thirty-eight copper tips were lost during transportation, having been but loosely attached.

The hard wood casing was in itself sufficiently strong and the nailing sufficiently thorough to secure stability. In justice to the shipper, it must be said that the manner of the packing, however prominent its weaknesses, indicated intention on his part to do a thorough job. Apparently, however, he possessed no previous experience in packing for export. The main fault was that all the cases were much too spacious for their contents. The heavy material was given the opportunity to flop from side to side and hence was subjected to tremendous strain when being handled, and on a rough, rolling sea.

The more delicate parts (shades, glass plates, and reflectors) ought to have been packed in separate boxes with a liberal use of excelsior or other soft material. Wrenches, latches, bolts, etc., ought to have been put up in small boxes, and not merely attached to the iron framework by means of thin wire, which wears out and breaks off in the course of a long journey.

However much the occurrence is to be regretted, the thing to do is to take the lesson to heart and to do better next time. It must be remembered that the question of packing has two sides to it—stability and appearance. In the case of heavy goods, stability is paramount. For lighter goods—like food stuffs, drugs, perfumery, soaps, etc.—appearance counts in winning popularity for an article. Neatness and tastefulness in the packing of goods attract attention.—J. F. Monaghan, Consul at Chemnitz.

Opening for Dried Fruits in France.—Several commission merchants at Nantes have requested me to secure for them the agency of responsible fruit-exporting houses in the United States. There is a growing market in all western and northwestern France for American dried fruits (the prunes of southern California being most in request), and the demand is unusually active this year because of the almost complete failure of the French fruit crop. Any of our fruit exporters who wish to be represented at Nantes need only communicate with this consulate.

The merchants here are interested in California prunes, dried apricots, and dried apples; they wish particularly to hear from California firms that will export these products direct to Nantes, as they do not care to do business through middlemen at Antwerp, Hamburg, and Liverpool.

The season is advancing, and if this excellent market interests any of our exporters who are not already represented in this territory, they should communicate at once.—Benj. H. Ridgely, Consul at Nantes.

New Docks Near Strassburg.—Consul J. I. Brittain, of Kehl, under date of May 14, 1903, reports:

Extensive new docks, extending from the River Rhine, have been constructed on a large expanse of territory between Kehl and Strassburg. These docks are far enough apart to permit the building of large manufacturing establishments upon the intervening land. The docks are constructed of solid masonry and equipped with every facility for discharging vessels plying between Strassburg and the ports of Antwerp and Rotterdam. The construction of the docks has already resulted in the erection of several factories—a sheet mill, a large lumber yard and planing mill, and an extensive flour mill. The lumber company (H. Fuchs & Son) imports considerable pine from the Southern States. The flour mill is six stories high, will have a capacity of 160 tons of grain per day, and will cost over $400,000. Wheat will be imported from various countries. Another flour mill of equal capacity will probably be erected in the same vicinity.

Passenger Elevator at Malta.—The local government authorities have advertised for tenders for the construction of a large passenger elevator. The custom house landing on the Marina being at sea level, and the principal business portion of the city of Valletta being located upon a high eminence, there is no way to reach the latter except by steep and winding streets. It is intended to construct an elevator from the brow of the town plateau to its base. Should any United States contractors be interested, application as below will provide all necessary information. The advertisement reads:

"OFFICE OF THE RECEIVER-GENERAL AND DIRECTOR OF CONTRACTS.

"Sealed tenders will be received at this office up to 11 A. M. on Friday, the 30th of October, 1903, for the concession of the right to construct a lift from the Marina to the Upper Barracca, as shown on a site plan which may be seen in the office of public works, and to work the same for a period of either sixty or ninety-nine years, together with the right to levy tolls and transit dues.

"1. Tenderers should specify the arrangements which they propose for providing the necessary capital and the period within which the work will be completed. Every tender should be accompanied with detailed plans and specifications of the proposed scheme.

"2. No tender will be considered unless it is signed by the party tendering and by a responsible person engaging to become bound with him for the due performance of the contract, and unless a deposit of £100 ($467) be paid in this office; such deposit to be forfeited in favor of the government should the party tendering or his surety, in the event of the tender being accepted, fail to appear to sign the contract within three days from the date of the notice given to them to that effect. Any deposit not so forfeited will be returned immediately after written notice shall have been given to the party whose tender is accepted.

"3. The government does not bind itself to accept the highest or any tender, and tenderers should be prepared to submit to any alteration in their plans which may be called for by the military authorities.

"4. Information regarding the conditions of the concession may be obtained at the receiver-general's office."—John H. Grout, Consul at Valletta.

Cattle Market in Mexico.—Consul W. W. Canada writes from Veracruz, May 16, 1903:

The Mexican government has conceded to Mr. William H. Alexander the privilege of establishing a permanent exposition and market for the sale of cattle, to be located within the limits of the Federal District. The concessionnaire will invest not less than $300,000 (about $135,000 gold) in the enterprise. Accommodations are to be provided for 5,000 head of beef cattle, 10,000 hogs, 5,000 sheep and goats, and 1,000 head of horses, mules, etc., and construction must be completed within five years. The concession is for the term of fifty years.

Greek Export of Currants.—Under date of May 6, 1903, Minister Jackson, of Athens, transmits the following statement with regard to the Greek currant trade from the beginning of the season (August 5, 1902), to the end of the month of February, 1903. The whole export amounted to nearly 223,000,000 Venetian pounds,* of which nearly 28,000,000 pounds, or more than one-ninth, went to the United States. England was the best customer, taking over 115,000,000 pounds; while both Holland and Germany took little more than the United States. The minister adds that an English syndicate† is negotiating with the Greek ministers for the purpose of obtaining the sole right to export currants from the country. They have not as yet been able to come to terms as to the price to be paid to the producers.

A report covering the same data has been received from Vice-Consul D. E. Maximos, of Patras.

Horse Meat in Paris.—Consul Thornwell Haynes reports from Rouen, May 13, 1903:

It is stated that at the Villejuit slaughterhouses 23,000 horses are killed annually and at Pantin 7,500, making a total of 30,500. Of this number, 10,500 are consumed in the environs of Paris, leaving a consumption of 19,500 in the city itself. The average weight of each horse is said to be 250 kilogrammes (551.15 pounds). One-third of this, however, is composed of bone and sinew, sold as waste at 4 francs (77.2 cents) per 200 kilogrammes (440.92 pounds). There remains, therefore, about 167 kilogrammes (368.17 pounds) of marketable meat to each horse, which would give a total consumption of 3,256,000 kilogrammes (7,178,177.6 pounds) annually.

The Osaka Exhibition.—Consul S. S. Lyon sends from Kobé, April 23, 1903, further newspaper clippings relative to the Osaka Exhibition, description of which appeared in Advance Sheets No. 1637 (May 4, 1903). In the display from Oregon, it is noted, 52 distinct establishments are represented. There is also an exhibit by Heinz, of Pittsburg, of pickles and other food products. The Japan Railway Company exhibits a railway train, with compartment, kitchen, dining car, etc. The Imperial Government Railway has a locomotive, one of two built at the government works at Kobé in 1900 as an experiment. It is designed for heavy work and appears to have given great satisfaction. It is mentioned that if either of these two engines were required to be duplicated in Europe or America, it would be necessary to send drawings, as they are not copies of any engine made abroad.

American Pork in Turkey.—Under date of April 28, 1903, Minister Leishman, of Constantinople, reports that the prohibition of American pork, which has been in effect in Turkey for the past five years, has been removed and orders issued to permit entry under usual examination.

Pier at Smyrna.—Consul R. W. Lane, of Smyrna, April 17, 1903, says:

Arrangements are being made by the Ottoman Railway Company, of Smyrna, to extend a stone pier some 200 yards into Smyrna Bay. It is proposed to expend $800,000 to $1,000,000 in its construction, and it is estimated that two years will be required for its completion. This may be of interest to American contractors.

Request for Delinting Machines for Cotton Seed.—Consul-General Robert P. Skinner writes from Marseilles, May 11, 1903, as follows:

I am informed by Messrs. Bendit, Limburger & Co., 4 Rue des Princes, of this city, that they can probably effect the sale of a number of American delinting machines for treating cotton seed, and they have requested me to obtain the addresses of manufacturers of such devices, together with prices and other information. Correspondence may be sent direct to the firm named.

Transit Dues on Goods for the Transvaal.—Consul W. S. Hollis sends the following from Lourenço Marquez, April 25, 1903:

As the government of Cape Colony has abolished the collection of transit duties on goods imported in bond to the Transvaal via Cape ports, and as the government of Natal has reduced its transit rate to 1 per cent, the governor-general of Mozambique has declared that after April 27, 1903, all goods entering this port for transportation in bond to the Transvaal that are not already free of transit duty will be subject to a transit tax of 1 per cent instead of 3 per cent. All signs point to the abolition of transit duties in the near future throughout South Africa.

Bonded Store[illegible] at Malta.—Consul John H. Grout reports [illegible] 1903:

American tobacco houses that [illegible] will be interested to learn that by a recent pro[illegible] bonded stores are to be allowed for local importers of tobacco. It is believed here that this will greatly facilitate business in this line, being a radical change over past regulations. Heretofore, the space for bonded imports under the complete control of the local authorities has been somewhat limited in area.

Proposed French Tariff on Wool.—Consul Thornwell Haynes writes from Rouen, May 13, 1903:

A prominent French Deputy has recently submitted a proposition to impose a duty of 10 francs ($1.93) per 100 kilogrammes (220.46 pounds) on wool, of whatever origin. Wools in the suit are now exempt from duty, there being only an insignificant tax on products of European origin imported direct from the country of production.

Venezuelan Duty on Pine.—Consul E. H. Plumacher sends from Maracaibo, May 8, 1903, the text of a recent decree by which the duties on logs of pitch pine of a thickness of more than 25 centimeters (9.8 inches) are abolished.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

* The Venetian heavy pound is equal to 1.05 American pounds; the light pound to 0.6 American pound.

† See Advance Sheets No. 1634 (April 30, 1903).

SELECTED FORMULÆ.

To Repair Roman Mosaics.—In Rome there are sold, as souvenirs, little boxes, plates, frames, etc., showing on a light even ground variegated but very pleasing flowers or ornaments in relief. Generally they are made of varyingly shaped mosaic sticks and very fragile, so that when the purchaser has hardly returned to his native country, he will already discover defects in them. If one is successful in finding all the little pins or sticks, which have fallen out or otherwise become dislodged, they may be returned to their places with the exercise of a little skill, and pasted in again, but when they have been lost, the situation is quite difficult.

Still, the author has been successful after many experiments, which were vain as regards the structure of the material, color, and durability, the primitive process being as follows:

The only material which with suitable treatment assumes almost perfectly the appearance and durability of the mosaic sticks is rice. The grains of rice have the necessary size, are translucent and can be cut with a fine sharp knife into any desired shape. That is the first operation. Next the empty places where the pieces are missing are moistened with thick gum arabic and they are inserted. It is well to allow the surface to protrude a little and to cut it off even after a few days when the grains are firmly embedded. Then they can be colored as required with good water colors, which they take readily, and when this is dry, go over the repaired places with fine spirit varnish.—Neueste Erfahrungen und Erfindungen.

Directions for Preparing Aqueous Menthol Preparation.—Owing to the circumstance that oil of peppermint and menthol are soluble in water only in very slight quantities the use of these two valued agents is rendered quite expensive, since it frequently becomes necessary to use alcoholic solutions, where aqueous solutions would do just as well.

This drawback, however, can be obviated by dissolving the menthol first in a little tincture of quillaja and then gradually adding the latter in small portions to the water. In this manner clear and permanent menthol mixtures are obtained.

For internal use the following mixtures are recommended:

Menthol	0.03 to 0.05 grammes
Tincture of quillaja	5 grammes
Glycerin	10 grammes
Water to make up	120 grammes

or

Menthol	0.15 to 0.30 grammes
Tincture of quillaja	10 grammes
Water to make up	150 grammes

As a mouth wash the following mixture has been found valuable:

Menthol	0.1 to 0.2 grammes
Tincture of quillaja	20 grammes
Solution of boracic acid 1 per cent	1,000 grammes

—Pharmaceutische Zeitung, Berlin.

Blue Print Paper.—The following process, credited to Capt. Abney, yields a photographic paper giving blue lines on a white ground:

Common salt	3 ounces
Ferric chloride	8 ounces
Tartaric acid	3¼ ounces
Acacia	25 ounces
Water	100 ounces

Dissolve the acacia in half the water and dissolve the other ingredients in the other half; then mix.

The liquid is applied with a brush to strongly sized and well rolled paper in a subdued light. The coating should be as even as possible. The paper should be dried rapidly to prevent the [illegible] sinking into its pores. When dry the paper is ready for exposure. In sunlight [illegible] of two minutes is generally sufficient to give an image, while in a dull light as much as an hour is necessary.

To develop the print, it is floated immediately after leaving the printing frame upon a saturated solution of potassium ferrocyanide. None of the developing solution should be allowed to reach the back. The development is usually complete in less than a minute. The paper may be lifted off the solution when the face is wetted, the development proceeding with that which adheres to the print. A blue coloration of the background shows insufficient exposure, and pale-blue overexposure.

When the development is complete, the print is floated on clean water, and after two or three minutes, is placed in a bath, made as follows:

Sulphuric acid	3 ounces
Hydrochloric acid	8 ounces
Water	100 ounces

In about ten minutes the acid will have removed all iron salts not turned into the blue compound. It is next thoroughly washed and dried. Blue spots may be removed by a four per cent solution of caustic potash.

The back of the tracing must be placed in contact with the sensitive surface.—Drug. Circ. and Chem. Gaz.

French Varnish.—So-called French varnish is made by dissolving 1 part of bleached or orange shellac in 5 of alcohol, the solution being allowed to stand and the clear portion then being decanted. The varnish may be colored by materials which are soluble in alcohol.

For red, use 1 part of eosin to 49 parts of the bleached shellac solution.

For blue, use 1 part of anilin blue to 24 parts of the bleached shellac solution, as the orange shellac solution would impart a greenish cast.

For green, use 1 part of anilin green (brilliant green) to 49 parts of the orange shellac solution.

For yellow, use either 2 parts of extract of turmeric or 1 part of gamboge to 24 parts of the solution or 1 part of anilin yellow to 49 parts of the solution.

For golden yellow, use 2 parts of gamboge and 1 part of dragon's blood to 47 parts of the orange shellac solution. The gamboge and dragon's blood should be dissolved first in a little alcohol.—Drug. Circ. and Chem. Gaz.

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